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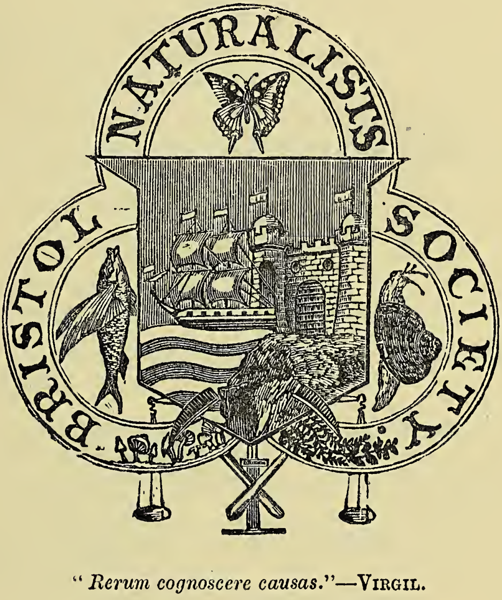

"*Rerum cognoscere causas.*"—Virgil.

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Note on the Iron-turnings Cell, and the supposed Influence of Points in the Liberation of Bubbles.

By A. M. WORTHINGTON.

THIS cell consists of an inner porous pot, containing a strong solution of caustic alkali, in which the zinc is immersed. The outer pot is of iron, and itself forms the kathode of the cell. The annular space between the two pots is packed with iron turnings, the interstices of which are filled up with the same liquid as the inner pot. The hydrogen, instead of forming a polarizing layer on the kathode, is intercepted by the rough pointed fragments of metal and is liberated in bubbles.

It is obvious that the same mechanical method of intercepting the hydrogen can be adopted in a sulphuric acid cell, if copper be substituted for iron, and the author has constructed cells which differ only from that of Daniell in having the copper sulphate solution replaced by fragments of copper turnings in sulphuric acid — the chemical hydrogen trap replaced by a mechanical trap. He has also used, instead of copper turnings, brass filings, which are but slightly acted on by dilute sulphuric acid. The acid used was diluted by 12 times its volume of water.

He found that any of these cells would give for several hours (3 to 12 hours), through a short external circuit, a current which did not vary by more than $\frac{1}{24}$ of its whole value.

But the electromotive force of such a cell as measured by Clarke's method was by no means constant. Thus, the E. M. F. of a copper-turnings cell, when first set up, is very nearly equal to that of a Daniell element, but after running for a few minutes through a very short external circuit it is reduced by nearly one-half.

An increase in the external resistance is accompanied by an increase in the electromotive force, and this is also the case with the iron cell, and with both the E. M. F. is increased by shaking the cell, which causes the disengagement of bubbles, which can be seen and heard as they come to the surface; so that it would appear that, with a given current passing through such a cell, a polarizing layer is formed whose efficiency, and probably whose thickness, depends on the rate at which the hydrogen can be liberated in the form of bubbles, in such a manner that an increase of current by causing the production of hydrogen to exceed the rapidity of escape increases the thickness and polarizing efficiency of the layer, and therefore diminishes the electromotive force of the cell.

Owing to this changeability of the E. M. F., it is difficult to obtain satisfactory measures of the resistance of the cell at any given moment.

It is customary to attribute the liberation of bubbles to the action of the *points* of the fragments of metal. The author is of opinion that this view is untenable, and that the bubbles have their origin in the crevices and hollows of the surface.

It is not possible in the case of the cell to see the growth of the bubbles; and the reason for assigning the liberation of the bubbles to the influence of points is that bubbles of steam in boiling water, and bubbles of gas in a gaseous solution, such as soda water, appear to be evolved at the points and edges of fragments of any foreign solid matter that may be present in the liquid.

Now with respect to the origin of bubbles of vapour in boiling, it is well established that the bubbles are not formed in the middle of the liquid, but only at the sides of the containing vessel; also that their formation may be almost indefinitely retarded by carefully getting rid of all adherent air. This is what we should expect from the consideration that the initiation of a bubble of vapour where no bubble of air already exists involves the overcoming of cohesion forces or adhesion forces across the surfaces which are to form the opposite sides of the bubble.

When a solid is dropped into a liquid, it generally takes down with it air adhering to the surface, as is shown by the immediate appearance of air bubbles when the atmospheric pressure is removed by an air pump. The manner in which the air is carried down may be readily understood from the following considerations:—Every solid surface, however smooth it may appear to the naked eye, reveals under the microscope many scratches and cavities. Time is required for a liquid to spread over the surface of a solid, even when it is wetted by the liquid, and the spread of a liquid such as water may be indefinitely hindered by the presence of greasy particles; so that if the air is to be completely expelled from the crevices, the solid must be so slowly immersed as to give the liquid time to spread over the sides of each cavity, and it will generally happen, owing to the rapidity of immersion, that the liquid will flow over the mouths of many pores and scratches without spreading into them so as to expel the air, which will thus be entrapped in minute bubbles.[1]

The same entrapping of air will take place on the sides of a vessel into which a liquid is poured, and there can be little doubt that the surfaces of the fragmentary matter at which bubbles appear contain minute invisible bubbles of air entrapped in this way.

---

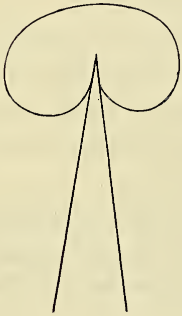
[1] The influence of roughness of surface in thus retarding the wetting of an immersed solid is fully discussed in a paper communicated by the author to the Royal Society and printed in abstract *Proc. Roy. Soc.*, vol. 34, 1882.

It is inconceivable that a perfectly smooth projecting solid point should be the seat of such an entrapped bubble; but it is to be observed that what appears to the naked eye to be such a smooth point, may in most cases be seen with a microscope to be an exceptionally rough portion of the surface; indeed, a point cannot project from a portion of the surface that has been well polished: it is the sign of a place that has escaped smoothing; thus the microscope shows the point to be the roughest place in a needle.

Again, it is well known that a piece of porous earthenware (*e.g.*, a bit of clay tobacco pipe) is one of the best means of securing a regular delivery of bubbles in a boiling liquid, and the author has observed that bubbles which were detached in great abundance from the apparently smooth surface of a sewing-needle immersed in a glass of soda water had their origin in a scratch which it required the microscope to reveal.

But the most conclusive argument of all against the formation of bubbles at true points is to be found in the consideration of the necessarily constant value of the contact angle between the liquid surface bounding the bubble and the solid against which it abuts. In the case of a liquid which wets the solid, the liquid angle between the solid-liquid surface and the liquid-gas surface is acute, and a bubble at a vertical point must have some such a form as that shown in fig. 1, and must necessarily slide up the point and entirely come away. Nor may it be urged that air bubbles really do escape in this way from points, and that their formation and delivery is rendered possible by the slowness of

Fig. 1.



the slipping motion when the bubbles are very small, for such bubbles, enveloping points in this way, are never to be found. On the other hand, bubbles of a size so considerable that they would at once escape by sliding, if attached in this manner to a point, may everywhere be seen clinging to the apparently smooth surface of the bottom of a glass of soda water, as in fig. 2, and this is precisely the appearance they present at the orifice of a narrow vertical tube (fig. 3).

Fig. 2.

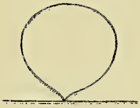
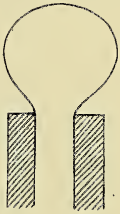


Fig. 3.



When such a bubble comes away from the tube it is because the surface becomes unstable and segments at the neck, and just as a hanging drop, when it comes away, leaves a little adherent liquid, so a little air is left behind when the bubble separates, and this will be sufficient to form the nucleus of a fresh bubble: hence we see a continual stream of bubbles coming away from the same place.

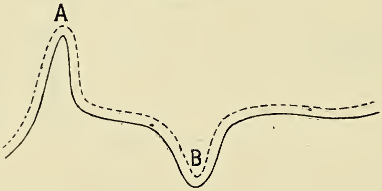
But since in the case of boiling the greater part of the air is diffused each time through the vapour of the escaping bubble, the quantity which remains becomes less and less in a geometrical progression, which accounts for our finally getting rid of the air by long boiling, without the necessity of supposing any appreciable proportion of it to be dissolved by the liquid.

It therefore appears that the common notion that points and edges determine the formation of bubbles in boiling liquids and gaseous solutions is due to the appearance of bubbles in the *neighbourhood* of points and edges, which from their very nature are signs of a rough and cavernous region of the surface.

It is probable, however, that in the case of the electrolytic evolution of gas the points of the kathode, or at least the edges of the hollows, play an important part in the adjustment of the thickness of the polarizing layer.

For a layer of gas of uniform thickness over an uneven surface, such as that represented (on an exaggerated scale) in vertical section in fig. 4,

Fig. 4.



cannot be in stable equilibrium owing to the variation of curvature of the surface. The capillary pressure on the gas is greatest at a projection A, and least at a depression B, and consequently there will be a flow of gas from A to B. The thickness at A will diminish, while that at B will increase. Now, the flow of electricity will be generally greatest towards a projecting point, such as A, and we may conceive that the hydrogen is evolved more rapidly at A than at B, but is at once forced down from A to B by the capillary pressure and there forms a bubble which finally escapes. If the layer of gas be extremely thin its flow will be impeded by friction with the liquid and with the solid, to a greater extent than when thicker, and if the thickness is less than the radius of molecular action the capillary pressure on the gas will be diminished; so that an increase in thickness corresponds to an increased rate of flow from a projection to a neighbouring hollow, and hence it follows that if the current in the cell is increased so as to increase the rate of evolution of hydrogen at A, the polarizing layer must increase in thickness to effect a corresponding increase in the rate of delivery at B, and if the polarizing efficiency of the gaseous film increases with its thickness we have here the explanation of the observed diminution of electromotive force with an increased current.

Note on a Remarkable Colony of Alien Plants.

By JAS. W. WHITE.

THERE is a spot in the parish of Kingswood, Gloucestershire, about four miles north-east of Bristol, which deserves mention on account of the extensive collection of alien plants known to have existed there for some years.

It is a small heap of shaly *dêbris* (about 50 yards by 25) on the slope of a hill, and surrounded by corn fields. This heap may have been the result of an old trial-boring for coal, but at present there is no pit or working in the near vicinity, and enquiries show that the place has remained undisturbed for about twenty years. Last summer a friend and I made several visits to the heap, and gathered on it the plants whose names are appended.

As a rule, the occurrence of foreign or alien plants in this country is not to be considered of any scientific importance. There are very many means by which such stragglers can be introduced: with corn and other agricultural seeds, with foreign fodder, or in the refuse from oil and flour mills, distilleries, and paper mills using imported material. Dock-sides and waste places about quays, where ship rubbish is thrown, ballast heaps, and the collected refuse of gardeners and farmers, are all situations where we may expect to find interlopers from far-off lands. Some of these have become so well-established, and have spread over so wide an area, that botanists have given them the rank of denizens or colonists. On the contrary, others are quite unable to maintain themselves in their new locations; they cannot ripen seed in this climate, and, not producing descendants, they disappear.

It would be manifestly unwise to encumber our books with names and localities for evanescent plants seen as single stragglers, or more numerously for a single season. "Like ornaments on the breast of beauty, they add no intrinsic value to the spot where they sparkle." The subjects of this note deserve notice mainly on account of their number, their long continuance, and the difficulty we find in ascertaining the cause of their introduction.

ALIEN TO BRITAIN.

Delphinium Ajacis
Farsetia incana
Erysimum orientale
Saponaria Vaccaria
Satureia hortensis
Trifolium supinum
Grindelia squarrosa
Centaurea paniculata
C. melitensis
Echinospermum Lappula
Thesium humile
Glaucium phœniceum
Camelina sativa
Gilia capitata
Silene dichotoma
Gypsophila muralis
Anthemis tinctoria
Achillea nobilis
Stachys annua
Salvia sylvestris
Plantago arenaria.

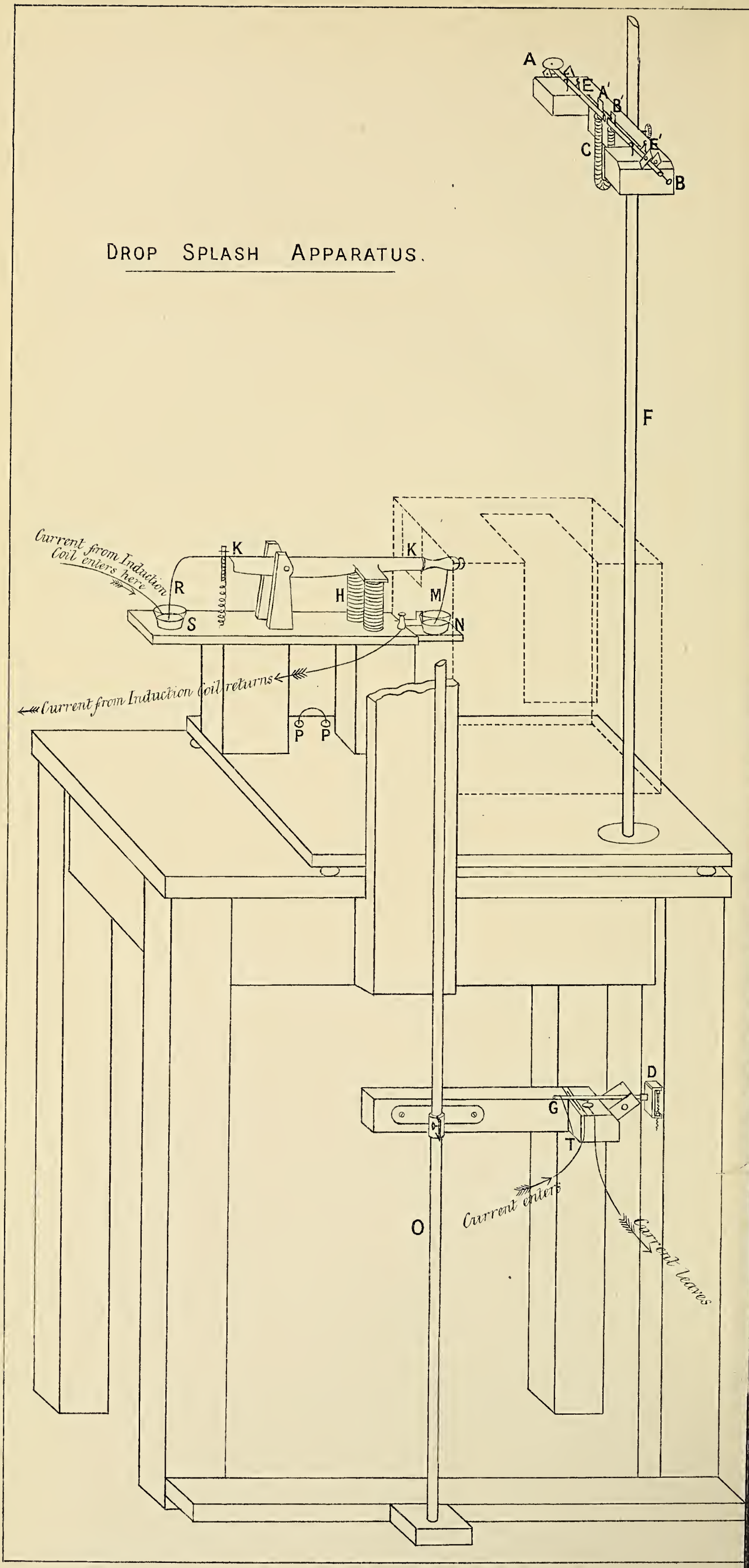
ALIEN TO THE BRISTOL COAL-FIELDS, BUT NATIVE OR COLONISTS IN OTHER PARTS OF THE COUNTRY.

Silene noctiflora
Medicago falcata
Apera Spica-venti
Dianthus prolifer
Bupleurum rotundifolium.

Alien to Kingswood, but Native or Colonists in other parts of the Bristol District.

Reseda lutea
Melilotus alba
M. officinalis
Centaurea Cyanus
Verbascum virgatum
Bromus arvensis
Trifolium arvense
Medicago sativa
Potentilla argentea
Echium vulgare
Festuca Myurus
Bromus madritensis.

DROP SPLASH APPARATUS.


A
E
A'
B'
E'
C
B
F
Current from Induction Coil enters here
K
R
S
H
K
M
N
Current from Induction Coil returns
P
P
D
G
T
Current enters
O
Current leaves

An Apparatus for Observing Splashes.

By A. M. WORTHINGTON.

THE author exhibited and explained the apparatus by means of which he has followed the very rapid changes of form which constitute a splash, whether of a liquid drop falling on a solid plate or of a liquid or solid sphere impinging on a liquid surface. The principle of the method consists in allowing the drop to fall in comparative darkness and then illuminating it by an electric flash at any stage of the splash which it is desired to observe. The same splash can always be reproduced by letting fall equal drops from the same height; and, by observing each at a stage slightly later—a few thousands of a second later—than the last, the gradual changes can be followed.

The apparatus by which the illumination was produced and timed is figured on plate 1. It may be premised that the flash used for illumination is that produced by breaking at the surface of mercury a current which has passed through a primary induction coil, and that the action of the apparatus consists in letting fall simultaneously with the drop (or solid sphere) whose splash is to be observed, a small ivory sphere which by striking a lever sets going the mechanical action which results in the flash, the timing of the flash being effected by the adjustment of the height of this lever.

A block which can be fixed at any height on the upright F carries two light wooden horizontal levers AA′, BB′ of about the dimensions of ordinary drawing pencils, and which are pivoted on horizontal axes. The lever AA′ carries at the end A a watch-glass on which the drop to be let fall is placed; this glass is smoked to prevent the adhesion of the liquid when a water drop is used. The lever BB′ carries at the end B a small wire ring on which the ivory sphere to be simultaneously let fall is placed. The other ends of the levers are provided with light iron armatures A′ and B′, which are attracted and held down by the poles of the electro-magnet C against the action of springs consisting each of an india-rubber ring stretched across two pegs at E and E′. When the current of the electro-magnet C is cut off these springs toss up the ends A′ and B′ of the levers, and the support of the drop at A and of the ivory sphere at B is thus removed simultaneously, so that drop and sphere begin to fall at the same instant.

The ivory sphere in its fall strikes the plate D at the end of the lever DG, whose height can be adjusted by sliding the block which carries it up or down the vertical rod O, whose upper support has been removed in the drawing for the sake of showing the part of the apparatus which it would conceal. This lever DG carries on its lower side a platinum wire, one end of which is bent down into a mercury cup, while the other crosses at right angles a second and fixed wire. When these two wires are in contact an electric current can pass from the fixed wire to the mercury, but the moment the plate D is struck the wire of the lever is lifted and the contact broken. To prevent the two wires from welding together at the point of contact, the lower is kept cool by being laid on a stout strip of copper; while to secure a good contact, the end G of the lever is held by an indiarubber band GT. The current which is thus broken has passed through a second electromagnet H, by whose attraction the lever KK is kept down against the action of a spiral spring at L. When the current of this magnet is broken, the motion of the lever caused by the spring causes the wire M to be withdrawn from a cup of mercury N, and by this means the strong primary current of an induction coil is broken at the surface of the mercury, the volatilization of which renders the flash particularly brilliant without unduly prolonging its duration. It is this flash which is used for illuminating the splash. It is produced inside a white cardboard box or screen, shewn in the diagram in dotted outline, which serves greatly to increase the illumination. This box is provided, as shown, with suitable openings to permit the entry of the falling drop and the motion of the lever KK. The plate or liquid on which the drop is to fall is placed inside.

In order to make an observation, the observer sits in an obscurely lighted room, facing the open side of this box or screen —on the remote side of the diagram—and looking at the place at which previous trial has told him that the drop will fall, and having placed the drop on the smoked watch glass A, and the ivory sphere on the ring B, he cuts off the current of the electro-magnet C by short circuiting it, which is done by connecting the two mercury cups PP′ by a wire bridge. This starts the fall, and, a moment later, he sees a particular stage of the splash lighted up. He then draws from memory what he has seen. If he is uncertain, he can repeat the experiment without altering the height of the plate D, when the same, or *very nearly* the same, stage of the splash will be again exhibited.

If he wishes to observe a later stage, he lowers the block carrying the plate D, and then repeats the operation. The distance through which he lowers it affords a measure of the time-interval between the two stages.

Since the current, whose interruption produces the illuminating flash, is only wanted when the flash is wanted, the wire RK, by which it passes, is so arranged that its end R does not quite reach the mercury cup S into which the current is led, so long as the lever KK is held down by the electro-magnet; but on the release of the lever, R is lowered and makes contact, so that the current passes, but is immediately after broken by the wire M leaving the mercury N and producing the flash. In this way the battery is kept from waste, and bichromate cells can be used without renewal for many weeks, which, but for this precaution, would run down in as many minutes.

For an account and explanation of the phenomena observed with this apparatus, the reader is referred to the *Proceedings of the Royal Society*, vol. 25, pp. 261 and 498 (1877), and vol. 34, p. 217 (1882).

[*Reprinted from the* REPORT OF THE BRITISH ASSOCIATION, 1882.]

The Porosity and Density of Rocks with regard to Water Supply.

BY E. WETHERED, F.G.S., F.C.S.

MY first object in commencing a series of observations on the porosity of rocks was with a view of investigating the lithological changes which are brought about by the percolation of water through them. But while engaged in work of this kind, one is struck with the great volume of water which the rocks of the earth are capable of absorbing, and a knowledge of this is important both as regards water-supply and the suitability of stone for building purposes. Much information on the subject has already been obtained by the investigations of the Rivers Pollution Commission, the Commission on Water Supply, and on the Selection and Decay of Stone for the Houses of Parliament. Also by the Committee appointed by the British Association for the Investigation of the Circulation of Underground Waters, and by Mr. De Rance, C.E., F.G.S., in his book on the Water Supply of England and Wales.

The method which I have adopted for arriving at the results contained in this paper is that recommended by Dr. Sterry Hunt in the Geological and Chemical Essays.[1] The portions of rock selected for the work were struck off by a blow with a hammer. By this means I was enabled to get clear and natural surfaces exposed. The whole of the results obtained are given in the annexed table.

---

[1] Pages 165-7.

The Arenaceous Rocks.—The oldest rocks which I have examined are those of the Old Red, and all the specimens were selected personally. Taking first the Old Red Sandstone we get an average specific gravity of 2·61, but the specimens from near Bristol have a decidedly lower specific gravity compared with others which are given. Excluding the flags from Caithness, the volume of water absorbed by a cubic foot of the rock is 0·707 of a gallon, or 59,000,000 gallons to the square mile 3 feet thick. The specimen of flags from Caithness absorbed much less water, and I found the same thing to apply to Old Red flagstones from other districts. The conglomerate beds are more absorbent than the sandstones: the average specific gravity is 2·58 and the volume of water absorbed by a cubic foot 0·805 of a gallon, or 67,000,000 gallons to a square mile 3 feet thick.

I next take the Millstone Grit. The specimens from Bristol, South Wales, and the Forest of Dean were selected personally, and for those from Sheffield I am indebted to the kindness of Dr. Sorby, F.R.S. The Millstone Grit which underlies the Bristol coalfield is something like 1,000 feet thick[1]; the chemical composition, the mean of five analyses, is as follows:—

Silica	97·80
Alumina	·47
Oxide of Iron	·80
Lime	·44
Carbon	·17
Carbonic Acid	·39
Moisture	·22
	100·29

---

[1] *Proc. Bristol Naturalists' Society*, 1875-6, page 336.

In some of the specimens of this grit, microscopically examined, the grains of silica appear to cement themselves together, and so closely, that it is difficult to distinguish their outline. The grains are, for the most part, sub-angular, and are either colourless or have a slight pink tinge imparted by oxide of iron. The specific gravity averages 2 60, and the amount of water absorbed by a cubic foot of the rock is 0·080 of a gallon, equal to 6,000,000 gallons to a square mile 3 feet thick.

Two typical specimens of Millstone Grit were selected from Pertyrch, South Wales; one a coarse variety and the other with grains averaging about 0·010 of an inch in diameter. There is a slight lithological difference when compared with the same formation around Bristol, and chemically it is a little more argillaceous, as shown by the following analysis:—

Silica	96·63
Alumina	1·15
Oxide of Iron	·70
Lime	·55
Carbonic Acid	·20
Carbon	·30
Moisture	·10
Alkalies not estimated	—
	99·63

The specific gravity may be taken at 2·57, the volume of water capable of being absorbed by a cubic foot of the rock 0·290 of a gallon, or 23,000,000 gallons to a square mile 3 feet thick.

The specimens of Millstone Grit from Sheffield resemble lithologically those of South Wales, though a person acquainted with the formations in the two districts would probably be able to distinguish between them. The grains composing the grit in the neighbourhood of Sheffield, according to Dr. Sorby, "are, on the whole, extremely angular."[1] The specific gravity averages

---

[1] *Quarterly Journal Geol. Society*, 188, page 64.

2·59, and the volume of water absorbed per cubic foot of rock is 0·504 of a gallon, equal to 42,000,000 gallons to a square mile 3 feet thick.

Two samples of Millstone Grit were collected from the Forest of Dean coalfield; one from the southern outcrop and the other from the northern. We here get a very different lithological character when compared with the same formation at Bristol and in South Wales, and a very much larger volume of water is absorbed. The rock resembles a Trias sandstone more than the Millstone Grit, but in chemical composition there is practically little difference, as is shown by the following analysis of a specimen from Drybrook:—

Silica	98·06
Alumina	·30
Oxide of Iron	·50
Lime	·33
Carbon	·20
Carbonic Acid	·30
Alkalies	Trace
	99·69

The specific gravity of the Forest of Dean Millstone Grit averages 2·63, the volume of water absorbed by a cubic foot of the rock is 0·854 of a gallon, or 71,000,000 gallons to a square mile 3 feet thick. Though I have given the average volume of water absorbed, it will be seen, on reference to the tabulated list, that the results obtained from the two specimens examined differ considerably. In the case of the one absorbing the greatest quantity of water, the grains composing it were but slightly cohesive, but in the other case the rock was of a more compact character.

Referring to the upland surface water from the Millstone Grit and the non-calcareous portions of the coal measures, the Royal Commissioners on Rivers Pollution say in their sixth report,[1] "Many of the large manufacturing towns of Lancashire and Yorkshire are supplied with water for potable and manufacturing purposes, by the storage in vast reservoirs of the upland drainage from these formations. Being but slightly absorbent they yield to the impounding rivulets and streams a large proportion of the actual rainfall." Though the Millstone Grit may be but slightly absorbent in the localities named, yet this character cannot be established as a rule by which one can be guided. In the case of the Bristol coalfield it applies, but when we come to the Forest of Dean we find the reverse to be the case. The Millstone Grit of the West of England serves as a good illustration of the variability of rocks in different localities, especially as regards the volume of water which is capable of being stored in them.

The next rocks examined were those of the Pennant Grit. It is necessary here to lay stress upon the definite article, as "the Pennant" is confined to the middle coal-measures of Bristol, and is also extensively developed in the Somersetshire and South Wales coalfields. There are, however, beds of grit in the lower coal-measures of Bristol, which are lithologically true Pennants. The Pennant Grit is a compact blue rock, made up of angular grains. The following is the mean analysis of seven samples taken from my paper on the "Composition of the Pennant Grit."[2]

Silica	84·96
Alumina...	4·34
Oxide of Iron	4·55
Lime	1·29
Carbon	2·86
Carbonic Acid	1·33
Magnesia	·05
Water	·58
	99·96

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[1] Page 40, part 2. [2] *Journal of the Chem. Society*, 1882, page 79.

The specific gravity of the Pennant averages 2·67, the water absorbed by a cubic foot of the rock 0·150 of a gallon, and by a square mile 3 feet thick 12,000,000 gallons. Speaking of deep wells in the Coal Measures, the Rivers Pollution Commissioners say:[1] The proportion of mineral impurity present in the deep well-water is always large, but varies within wide limits. The water was found to contain, "as a rule, larger proportions of organic elements (organic carbon and organic nitrogen) than are met with in similar waters obtained from other strata," the average proportion being 0·153 parts per 100,000 parts, or ·107 grains per gallon. I quite endorse what the Commissioners say in respect to water from the coal measures generally, but where we have a great thickness of rock, as in the case of the Pennant around Bristol and Swansea, I think there may be an exception to what has been stated. Some years ago, it was proposed to supply a portion of Bristol with water from the Frampton Cottrell iron mines, which are in the Pennant, and the analyses made of the water showed it to be of good quality. Considering the quantity of water which this rock is capable of storing, the quality becomes a matter of great importance to villages and towns in the vicinity.

The only specimen of Triassic sandstone which I have had an opportunity of examining is that of the Bunter, from Heidelberg, Germany. The specific gravity was 2·55, and the volume of water absorbed by a cubic foot of the rock was 0·838 of a gallon, equal to 70,000,000 gallons to a square mile 3 feet thick. Mr. I. Roberts, F.G S.,[2] has made observations on the porosity of the Bunter from the Pebble Bed of Everton, and found the absorption to be 0·733 of a gallon of water to the cubic foot of rock.

The Calcareous Rocks. — Coming to the calcareous rocks which I have examined, I have classed among them the Magnesian Conglomerate, which I take first. The average specific gravity is 2·73, and the volume of water absorbed by a cubic foot of rock varies between 0·082 and 0·368 of a gallon, or between 6,000,000 and 30,000,000 gallons to a square mile 3 feet thick. This rock is extensively used for building purposes, and a knowledge as to the porosity of the various beds is therefore important in this respect as well as for water supply. It would appear from the specimens which I have examined, that the finer the conglomerate the more water there is absorbed.

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[1] Sixth Report, page 91.

[2] Fourth Report Underground Water Committee, page 16.

Of the Magnesian Limestone, two specimens were examined, both selected from the same locality. The average mean specific gravity is 2·77, the water absorbed by a cubic foot of the rock 1·031 gallons, and by a square mile 3 feet thick, 86,000,000 gallons.

The Magnesian Limestone is much more porous than the Carboniferous Limestone, which I take next. All the specimens were obtained personally, the first three from the lower shales. These gave a specific gravity of 2·71, with a porosity of 0·028 of a gallon of water to a cubic foot of rock, which is equal to 2,000,000 gallons to a square mile. The specific gravity of the specimens representing the limestone gave an average of 2·70. The volume of water absorbed by a cubic foot was ·043 of a gallon, or 3½ million gallons to a square mile 3 feet thick. From these comparisons it would seem that the lower shales are least porous. Considering the large volume of water which these rocks supply, their not being porous will seem contradictory; the fact is, however, that the water finds its way through joints and fissures, dissolving away the limestone, and sometimes forming subterannean reservoirs.

We next come to rocks which are very pervious; some of them, so far as their absorption of water is concerned, may be compared to an ordinary sponge. The rocks to which I allude are those of the Oolites. The specimens of the Great Oolite were personally selected from near Bath. The average specific gravity is 2·52, the water absorbed by a cubic foot of rock 1·706 of a gallon, or 142,000,000 gallons to a square mile 3 feet thick. The soft variety is the most absorbent. The specimens of Inferior Oolite were personally selected from near Cheltenham, with the exception of one from near Bath. As this rock is so extensively used for building, and on account of the great volume of water which the beds contain, I have examined a number of representative specimens, but the variation in the porosity is so great that no reliable average can be given of the volume of water capable of being absorbed. The bed which absorbed the least was a hard variety of Oolite taken from below the Pisolite bed of Leckhampton Hill, near Cheltenham; and the bed which aborbed the most was a soft variety of freestone from the same locality, but higher up in the series. The first of these gave 0·146 of a gallon to the cubic foot, or 13,000,000 gallons to the square mile 3 feet thick; and the second 2·202 gallons to the cubic foot, or 184,000,000 gallons to a square mile 3 feet thick. We, may, therefore, take it that the yield of water from the Inferior Oolite varies between those limits.

The Relation of Specific Gravity to Porosity.—In the report on Selection and Decay of Stone of the Houses of Parliament in 1839,[1] it is said that the specimens of rock which had the greatest specific gravity absorb the least quantity of water, though there are individual exceptions. I cannot say that my observations bear out this rule, and I doubt whether any such rule can be laid down.

The Relation of the Size of Grains composing a Rock to the Porosity.—In the tabulated results I have given a column in which the size of the grains composing the rocks is given. The object of this was to ascertain whether any relation existed between the size of the grains and the porosity. In the sandstones and grits there appears to be no connection whatever, but in the Magnesian Conglomerate the finer the material of which a bed is made up the more water there seems to be absorbed. In the case of the Oolites the more compact the rock the less porous it becomes.

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[1] Page 36.

The Purity of the Water.—On account of shallow well-water being almost invariably contaminated with organic matter, the Royal Commissioners on Rivers Pollution have classed shallow well-water as dangerous. On the other hand, deep well-water is classed as wholesome. It is, therefore, clear, that if shallow well-water is dangerous and deep well-water wholesome, there must be a purifying process going on during the percolation of water through the strata. I have given the analyses of samples of Millstone Grit and of the Pennant Grit, and on an examination of these it will be seen that the grits are practically composed of grains of silica. There is, therefore, nothing in the chemical composition of the rock which could purify the water except mechanically, and in order to get rid of organic contamination there must be oxidation. We must, therefore, look to another source than the chemical composition of the rock for the oxidising agent, and I think it will be found in the air absorbed by the water and in the air contained by the rock. The water in the strata is constantly being drained by springs, wells, and outlets by which the water-level is reduced. During a dry period, then, the interstices of the upper portions of porous rocks must be either occupied by air or there must be a vacuum. The former of these two conditions is the most probable, and it seems reasonable to assume that the oxygen of this air must oxidise any organic matter contained in water percolating through the earth. I have made observations with a view of ascertaining the volume of air absorbed by certain rocks. I have endeavoured to arrive at the result by displacing the air contained in given specimens by water. I have found the volume of water absorbed, and reduced it to the weight of air, assuming that water at 62° F. is 819·4 times heavier than air at the same temperature. By this means I find that a cubic foot of Inferior Oolite, absorbing 1 gallon of water, would, in the event of complete drainage off of the water, absorb 0·16 of its volume of air. In short, we find in the rocks of the earth much the same process going on naturally as the London water companies are doing artificially for the filtration of the London water-supply. The following is a section of the filter-beds of the Chelsea Waterworks, for which I am indebted to the manager, Mr. Lott :—

	ft.	in.
Fine Sand	3	6
Shells[1]	0	4
Shingle	2	0
Coarse Shingle[2]	2	2
Total[3]	8	0

The chemical analysis of the top bed of the filter, which does the work, gave the following :—

Silica	90·05
Alumina	·40
Oxide of Iron	6·90
Carbonaceous Matter	·70
Carbonic Acid	1·50
Magnesia	·01
Alkalies	Trace
Moisture	·26
	99·97

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[1] To keep the upper layer from mixing with the lower.

[2] Gradually increases in coarseness towards the base to prevent the pipes which carry off the water from becoming clogged.

[3] The arenaceous material is taken from the Thames, and is well cleansed by a powerful hose playing upon it.

The rate of filtration is 2 gallons per hour.[1] By comparing the chemical analysis of the filter-bed with those of the Millstone Grit and of the Pennant Grit, it will be seen that to all practical purposes the analyses are the same. There is nothing in the chemical composition of the filter which can oxidise the organic impurities of the Thames water passing through, but the oxidation is effected by air between the grains of sand with perfect effect. It is much the same with water percolating through the rocks of the earth; it comes in contact with air collected in the interstices. With such rocks as the Mountain Limestone, however, where the water yielded comes through fissures and joints in the strata, and does not percolate, it is a question whether the purifying process would be always satisfactory.

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[1] Colonel Bolton's Report for February, 1882, for which I am indebted to the courtesy of Colonel Bolton.

TABLE OF THE DENSITY AND POROSITY OF ROCKS.

Geological formation examined.	Locality.	Size of grains in decimals of an inch.	Specific gravity of the mass, water=1.	Specific gravity of the particles, water=1.	Volume of water absorbed by 100 volumes of rock.	Gallons of water absorbed per cubic foot of rock.	Gallons of water absorbed per square mile of rock 3 feet thick.
Old Red Sandstone . .	Bristol . . .	Irregular ·009 to ·004	2·59	2·89	10·30	·642	53,754,000
,, ,, . .	,, . . .	·007	2·57	2·86	9·97	·622	52,000,000
,, ,, . .	Gloucestershire	·008	2·60	2·96	11·60	·723	60,538,000
,, ,, . .	,, .	—	2·63	3·04	13·53	·844	70,610,000
Old Red Flags	Caithness . .	—	2·66	2·70	1·39	·086	7,254,000
Old Red Conglomerate .	Gloucestershire	—	2·62	3·22	18·79	1·172	98,000,000
,, ,, .	,, .	—	2·60	2·96	11·60	·723	60,536,000
,, ,, .	,, .	—	2·63	3·04	13·53	·844	70,610,000
,, ,, .	,, .	—	2·62	2·93	10·29	·642	53,701,000
,, ,, .	,, .	—	2·63	2·97	11·43	·713	59,651,000
,, ,, .	,, .	—	2·42	2·81	11·84	·738	61,791,000
Millstone Grit	Bristol . . .	·003	2·63	3·01	1·66	·103	8,663,000
,, ,, ...	,, . . .	·003	2·57	2·61	1·34	·083	6,993,000
,, ,, ...	,, . . .	·006	2·62	2·64	·93	·058	4,853,000
,, ,, ...	S. Wales . . .	Very coarse and irregular in size	2·55	2·70	5·70	·355	28,747,000
,, ,, ...	,, . . .	·010	2·60	2·69	3·62	·225	18,892,000
,, ,, ...	Sheffield . . .	·009	2·60	2·81	7·54	·470	39,350,000
,, ,, ...	,, . . .	·014	2·59	2·84	8·65	·539	45,142,000
,, ,, ...	Forest of Dean .	·009	2·65	2·90	9·44	·589	49,265,000
,, ,, ...	,, .	·011	2·62	3·19	17·94	1·119	93,625,000

Pennant Grit	Bristol	·004	2·67	2·73	2·24	·139	11,690,000
,, ,,	,,	·011	2·68	2·73	1·63	·101	8,506,000
,, ,,	,,	·009	2·65	2·73	2·86	·178	14,925,000
,, ,,	S. Wales	—	2·66	2·71	2·18	·136	11,377,000
,, ,,	,,	—	2·69	2·50	3·18	·198	16,595,000
Coal Measure Grit (Pennant Type)	Bristol	·005	2·69	2·74	1·18	·112	9,446,000
Ditto, same quarry	,,	·007	2·74	2·75	·68	·042	3,548,000
Coal Measure Grit (Millstone Grit Type)	,,	·006	2·60	2·72	4·39	·273	22,910,000
Bunter Sandstone	Heidelberg	—	2·55	2·94	13·43	·833	70,889,000
Mag. Conglomerate	Clifton	Coarse	2·74	2·78	1·34	·082	6,993,000
,, ,,	,,	,,	2·74	2·80	2·14	·133	11,168,000
,, ,,	,,	Fine	2·72	2·86	5·28	·329	27,555,000
,, ,,	,,	,,	2·73	2·90	5·90	·368	30,791,000
,, ,,	S. Wales	Coarse	2·73	2·80	2·36	·147	12,316,000
,, Limestone	Clifton	—	2·80	3·24	16·33	1·018	85,223,000
,, ,,	,,	—	2·75	3·30	16·74	1·044	87,363,000
Carb. Limestone, L.S.	,,	—	2·70	2·71	·17	·010	887,000
,, ,, ,,	,,	—	2·70	2·71	·41	·025	2,139,000
,, ,, ,,	,,	—	2·74	2·76	·79	·049	4,122,000
,, ,,	,,	—	2·70	2·72	·50	·031	2,609,000
,, ,,	,,	—	2·72	2·74	·70	·043	3,653,000
,, ,,	Gloucestershire	—	2·70	2·73	·92	·057	4,801,000
Great Oolite	Bath	Hard	2·59	2·98	23·62	1·473	123,268,000
,, ,,	,,	,,	2·39	3·14	23·88	1·490	124,625,000
,, ,,	,,	Soft	2·60	3·98	34·57	2·157	180,415,000
Inf. ,,	,,	—	2·67	3·80	29·72	1·854	155,103,000
,, ,, Building Stone	Cheltenham	—	2·67	3·51	23·98	1·496	125,147,000
,, ,, ,, ,,	,,	—	2·69	3·21	16·22	1·012	84,649,000
,, ,, Soft Freestone	,,	—	2·55	3·94	35·29	2·202	184,172,000
,, ,,	,,	—	2·67	2·91	8·22	·512	42,898,000
,, ,, Limestone	,,	—	2·68	3·15	12·15	·758	63,481,000
,, ,, Pisolitic	,,	—	2·70	2·76	2·3	·146	12,264,000

Notes on Ridgway's Catalogue of North American Birds (1881).

By H. J. CHARBONNIER.

IT is a pleasant task for the naturalist, who has not the leisure time that original work requires, to review the work of others; to reap where he has not sown; to find ready summarized the long and patient investigations of his more fortunately circumstanced fellow naturalists; and to note the gradual growth and development of his favourite branch of enquiry.

I was so much struck with the progress indicated in the last published catalogue of North American Birds, by Robert Ridgway, that I thought a short review of this carefully elaborated list might prove of interest.

Previously to this (1881) catalogue, the standard has been the list published in 1859 by Spencer F. Baird. A comparison of the two catalogues shows how great has been the amount of work accomplished by American ornithologists, and what rapid strides ornithology has made and is making amongst them.

I cannot do better than quote, briefly, from the very comprehensive introduction.

"Since the publication, in 1859, of the last Smithsonian Catalogue of North American Birds, so many important changes have been made in the nomenclature of the species, and so numerous have been the accessions to the fauna, that the wants of ornithologists require a new list which shall bring the subject fully up to date. It also appears desirable that an analysis should be given of the principal points of variance, numerical and otherwise, between the list which is herewith presented and that which has for so many years been the standard of reference; while, in order to further increase the utility of the list, a brief review of the revisions of nomenclature which have been adopted, the species added to the fauna, and other matters of like interest, is given under appropriate headings. . . . . . .

"The following enumeration contains 226 valid species and recognized races which have either been first described or added to the North American fauna since 1859, while, on the other hand, no less than 42 names of the old catalogue have been relegated to the ranks of synonymy (and 20 more removed as extralimital). Furthermore, of the remaining 698 names, over 300 have been more or less emended, so that only 395 of the 760 names as given in the old catalogue are retained in the current nomenclature!

"In the present list only those forms which are assumed to be specifically distinct have separate *numbers*, the sub-species or races being distinguished by a *letter* of the alphabet *(a, et seq.)* affixed to the species *number*.

"The adoption of trinomials for the designation of nascent species—a direct result of the synthetic method of study which has supplanted the former analytic treatment of the subject—has caused perhaps the greatest difficulty encountered in the compilation of this catalogue, it being in many cases very difficult to decide whether a given form should be treated as having passed the 'varietal stage,' and therefore to be designated by a *binomial*, or whether it is yet incompletely differentiated, and to be subordinated in rank by a trinomial appellation. . . . . .

"No other method seems at all adequate to the proper discrimination between isolated and intergrading forms, and the difficulty in the cases above alluded to arises wholly from the want of sufficient material to decide the question of intergradation or the contrary.

" Every form whose characteristics bear unmistakeably the impress of climatic or local influences, gradually less marked toward the habitat of another form, with which it thus intergrades, and all forms which certainly intergrade, no matter how widely distinct the opposite extremes may appear *(e. g., Colaptes Auratus* and *C. Mexicanus,* and the different races of *Passerella),* together with intergrading forms whose peculiarities are not explained by any known 'law' of variation, have been reduced to subspecific rank (and distinguished by a trinomial).

" On the other hand, where the difference between allied forms is slight, but at the same time apparently constant, and not necessarily coincident with a difference of habitat, specific rank is upheld." . . . .

I cannot help thinking that this adoption of a trinomial system of classification marks a very decided advance on our older methods of classification. There has been of late a great tendency amongst systematic ornithologists to increase the number of species to an alarming extent; every little local variation has been taken to justify a new specific appellation; as, for instance the division of the British forms of "Cole Titmouse," "Long-tailed Titmouse," and others, from the European forms of the same species (as in Dresser's magnificent work).

Anyone who is accustomed to seeing a large number of specimens of any British-European species cannot fail to remark a very decided difference in the two forms. I have often noted how easily I could pick out European specimens of "Marsh Titmouse," "Creeper," "Tawny Owl," "Common Heron," and others, from amongst British specimens of the same species; they have a decidedly distinct character, generally the colours are clearer, and the size perceptibly larger in the European forms. I expect in a few years each of these slightly differentiating forms will receive a distinct specific name.

Furthermore, as soon as three or four slightly divergent species are found to have a few characteristics in common, these three or four species are erected into a new genus, and our already far too numerous generic names are further increased. This continual increase in generic and specific names is most confusing and burdensome to the student.

The "Trinomial" system will, I believe, be nearly as great an improvement as the "Binomial" was over the chaos of nomenclature which preceded it.

The great point in any name, the great help to the student in fixing it in his memory, is that it should give him a clue to the *analogies of the species;* and as clearly defined species are invariably named first, and most easily recognized, the more obscure and intergrading forms should be named so as to shew clearly their analogy to well-known forms.

Take, for instance, the two woodpeckers on the table. No. 1 is the "Golden-Winged Woodpecker or Flicker," *Colaptes Auratus.* This form is the best known, and occurs all over eastern North America, to the eastern slopes of the Rocky Mountains, and as far north as Greenland. Look now at No. 2, the "Red-Shafted Flicker," *Colaptes Mexicanus.* This form occurs in western North America, from the Black Hills to the Pacific.

Now these two forms were described as two species by Swainson—*Colaptes Auratus* and *Colaptes Mexicanus.* Since then, an intermediate form has been found, and designated as *Colaptes Hybridus,* and these stand as three species in Baird's Catalogue of 1859, but in Ridgway's Catalogue they are reduced each to their proper value as under :—

378. *Colaptes Auratus.* (The commonest and best known form.)

378*a*. *Colaptes Auratus Mexicanus.* (The western form.)
378*b*. *Colaptes Auratus Hybridus.* (This form is a true Hybrid, produced from the other two, and occurs in the upper Missouri.)

The student, on reading these three names, sees at once the analogy between the three forms, and learns besides something of their history, which treating each by a different specific name would not have given him.

Another advantage of the trinomial system is to designate the American form of a well-known old world species; for instance, the "American Barn Owl" is distinguished from the universally known European form ("*Aluco Flammeus*" as "*Aluco Flammeus Americanus*," instead of the distinct specific name of "*Strix Pratincola*" in Baird's list.

There are no less than 160 forms subordinated by the use of trinomials in the present catalogue!

In conclusion, I would recommend our ornithologists carefully to note the truly scientific methods and the thoroughness of work indicated by this catalogue.

There is one thing I should like to have seen added, and that is the habitat and geographical range of each species, as in Baird's Catalogue of 1858; but this of course would have greatly extended the size of the book.

Geographical distribution, and the migration, or rather oscillation, of species between their northern and their southern limits is a subject which we English ornithologists cannot study with the same facility as our North American brethren; their enormous territory, the boundaries of which (as in the present catalogue) extend from the North Pole to the Mexican Gulf, presents them with a magnificent field of observation, and a large majority of the species indicated as North American, actually rear their young (the true claim to being considered natives) in some portion or other of the territories.

It is far different in the British avifauna, out of a list of over 400 species not more than one third can be really and accurately described as British.

A plant found growing in a wild state in Great Britain may correctly be called British; but what shall we say to a species of bird obtained (perhaps only once) whilst flying over our little island, at a rate, possibly, of 150 miles an hour! Even in the case of our regular and common visitors, would it not be more accurate to label, for instance, a Redwing—

Turdus Iliacus.—Habitat, the northern and central portions of Scandinavia; obtained during its autumn migration; at ———.

than to label such a bird "British"?

Our knowledge of species would greatly gain by a more accurate and scientific method being adopted by collectors. There is an infatuation amongst them for collecting only "British Birds," whatever they may understand by that vague expression; or worse again, "British Birds' Eggs," the actual *specimens* of eggs so designated being, in the majority of cases, obtained on the continent or elsewhere, and very often are laid by birds subspecifically different from those whose name they bear.

It is only by the greatest accuracy in keeping record of facts, and most carefully guarding against hazy and uncertain definitions, that any advance can be made towards determining what is, and what is not, a species.

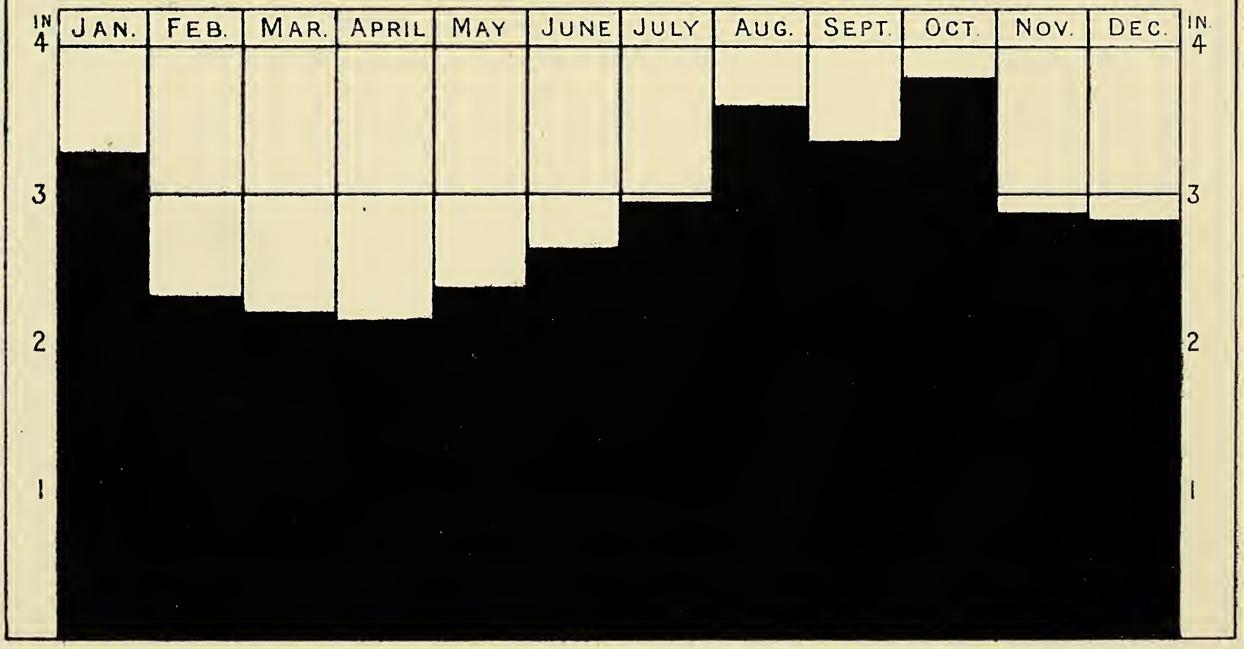
Rainfall at Clifton in 1882.

By GEORGE F. BURDER, M.D., F.M.S.

TABLE OF RAINFALL.

	1882.	Average of 30 Years.	Departure from Average.	Greatest Fall in 24 Hours.		Number of days on which ·01 in. or more fell.
				Depth.	Date.	
	Inches.	Inches.	Inches.	Inches.		
January ...	2·718	3·251	−0·533	0·842	2nd	10
February ...	2·438	2·318	+0·120	0·692	28th	13
March	2·294	2·216	+0·078	0·473	25th	16
April	4·068	2·144	+1·924	0·570	25th	18
May	1·928	2·362	−0·434	0·505	25th	12
June	3·372	2·623	+0·749	0·523	22nd	21
July	6·180	2·959	+3·221	1·040	23rd	21
August... ...	5·177	3·595	+1·582	1·328	28th	14
September ...	2·696	3·355	−0·659	0·594	1st	14
October ...	7·135	3·793	+3·342	1·789	23rd	22
November ...	5·819	2·856	+2·963	0·966	23rd	20
December ...	4·455	2·841	+1·614	0·640	29th	23
Year	48·280	34·313	+13·967	1·789	Oct. 23rd	204

Remarks.—The year 1882 will be memorable as having been (in this district at least) by far the wettest in a period of thirty



MEAN RAINFALL AT CLIFTON IN EACH MONTH OF THE YEAR.

years. The quantity of rain measured at Clifton during the year was no less than 48·280 inches, exceeding the average by nearly 14 inches. The nearest approach to this quantity in previous years was in 1875, when 44·047 inches were registered within the year. In 1882, nine months out of the twelve had rainfalls more or less exceeding the average, the exceptions being January, May, and September, in each of which months there was a moderate deficiency of rain. April, July, and October were the wettest recorded examples of those months respectively. The rainiest month of the year was October, which is also the rainiest on the average. In October, 1882, the fall was 7·135 inches, of which about 3·7 inches fell within an interval of 60 hours, causing the remarkable floods of the 24th of October. The driest month of the year was May, yielding 1·928 inch.

Three rainless (or nearly rainless) periods of some duration were noted in the course of the year—one in January, lasting 18 days; another in May, lasting 16 days; and a third of similar duration in July and August, which was opportune for harvest work.

Bisecting the year, we find that much the larger part of the excess of rain occurred in the latter half of the year. From January to June the rainfall was 16·818 inches, which is not quite two inches above the average. From July to December it was 31·462 inches, which is more than twelve inches above the average.

Diurnal falls exceeding an inch occurred on the 23rd of July, on the 28th of August, and on the 22nd and 23rd of October. The largest amount collected in any one rainfall-day (9 a.m. to 9 a.m.) was on the 23rd of October, 1·789 inch.

The greatest depth of snow on the ground during the year was 2 inches, on December 7th and 13th. Throughout the winter of 1881-82 no snow lay on the ground.

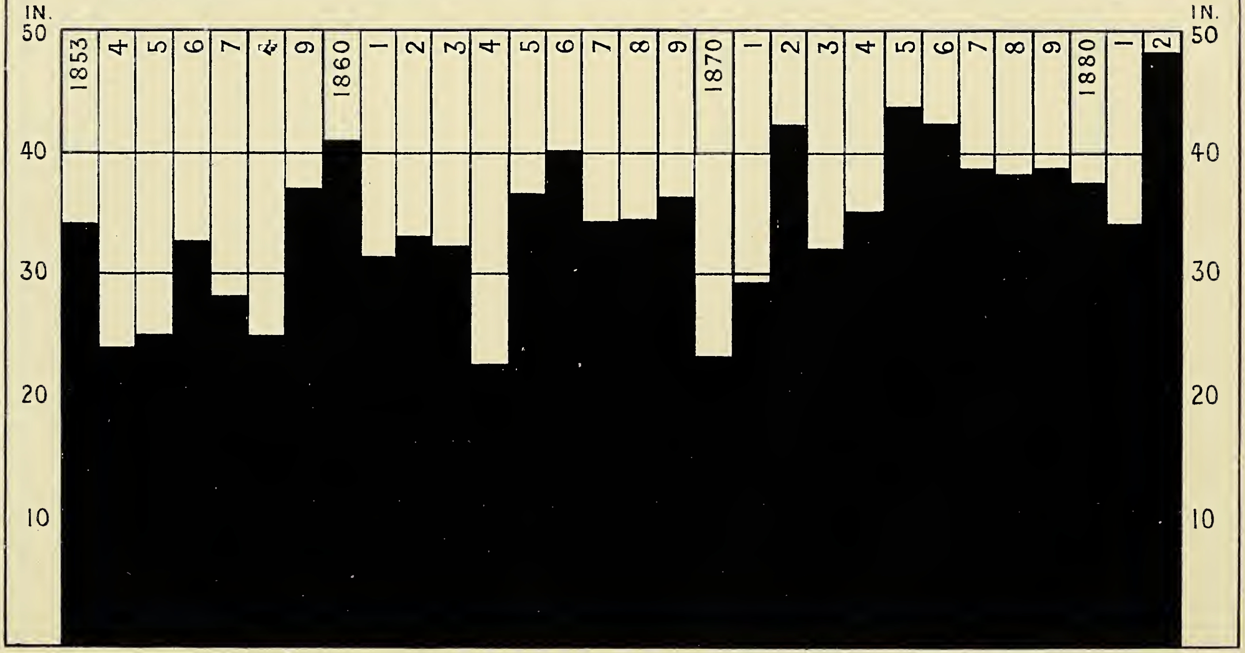
Thirty Years' Rainfall at Clifton.

By GEORGE F. BURDER, M.D., F.M.S.

THE tables and remarks which follow have reference to observations of rainfall taken at No. 7, South Parade, Clifton, from the 1st of January, 1853, to the 31st of December, 1882. The lawn on which the rain-gauge was placed has an elevation of 192 feet above the mean sea level. The position is sufficiently open in every direction, without being unduly exposed. The receiving area of the gauge was six inches above the surface of the ground, except during the last two years, when, with a new instrument, the height was twelve inches. The diameter of the receiving area has been throughout eight inches. The observations have been uninterrupted, and, with few exceptions, the gauge has been emptied daily when rain has fallen. It is scarcely necessary to add that under the term "rainfall" are included the liquid equivalents of snow and hail.

In Table I. are given the quantities measured in each of the 360 months over which the observations extend, with the 30 annual totals.

The figures in Table II. are extracted from Table I. They indicate the smallest and largest amounts registered in each month of the year, and in the whole year. It will be seen that the two driest months of the series were April, 1854, and September, 1865, in each of which the amount of rain collected was 0·022 inch; while the wettest month was August, 1865, yielding 8·508 inches. Of the years, the driest was 1864, the wettest, 1882. In 1864 the total fall was no more than 22·746 inches; in 1882 it amounted to 48·280 inches.



RAINFALL AT CLIFTON IN EACH YEAR FROM 1853 TO 1882.

TABLE I.

RAINFALL AT CLIFTON IN THIRTY YEARS.

Year.	Jan.	Feb.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Year.
	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.	In.
1853	2·994	0·733	0·544	3·125	2·335	4·385	4·787	4·486	3·324	3·934	2·946	0·607	34·200
1854	3·206	1·013	0·670	0·022	3·398	3·069	2·534	1·338	1·089	3·340	1·988	1·996	23·663
1855	0·311	1·462	2·166	0·429	2·188	3·628	3·490	2·789	0·849	6·060	0·541	0·992	24·905
1856	3·455	1·868	1·193	3·666	3·142	1·669	1·737	4·694	5·240	2·730	0·720	2·465	32·579
1857	2·707	1·552	1·883	2·857	2·074	2·108	2·501	3·968	2·215	3·275	1·668	1·071	27·879
1858	1·201	1·165	1·073	2·904	2·468	2·006	1·911	2·062	3·270	2·673	1·503	2·884	25·120
1859	1·995	1·654	4·747	2·955	2·390	1·929	3·938	3·950	4·185	2·224	3·045	3·861	36·873
1860	4·943	0·994	2·915	1·688	3·539	7·104	1·869	5·682	2·434	3·027	2·828	3·775	40·798
1861	1·033	2·751	2·935	0·305	1·385	3·339	4·534	2·568	3·860	2·283	4·860	1·459	31·312
1862	3·203	0·413	4·496	3·135	3·358	2·728	2·536	1·447	2·389	5·717	1·469	1·982	32·873
1863	4·087	0·809	0·832	1·894	2·252	4·645	0·509	3·879	3·584	5·203	2·903	1·666	32·263
1864	1·564	1·881	2·623	1·395	0·865	2·123	1·002	1·121	3·356	1·895	2·945	1·976	22·746
1865	3·764	2·879	1·157	0·729	1·986	1·578	4·233	8·508	0·022	4·969	3·253	3·426	36·504
1866	4·217	4·801	2·090	1·684	1·115	3·622	2·663	3·254	7·404	1·919	2·394	4·945	40·108
1867	4·867	2·712	4·865	3·410	2·520	2·069	2·728	2·046	1·338	3·643	2·200	1·570	33·968
1868	5·898	1·970	1·790	2·306	1·764	0·639	0·882	5·761	2·995	2·755	1·673	5·672	34·105
1869	5·368	3·882	1·203	1·126	6·304	1·026	0·957	1·396	5·775	2·439	2·399	4·296	36·171
1870	2·477	1·400	1·576	0·566	1·545	0·619	1·472	2·000	1·770	5·333	2·741	1·930	23·429
1871	2·118	1·560	1·495	3·759	1·206	1·447	5·114	1·865	5·239	2·430	0·626	2·238	29·097
1872	6·416	4·187	2·202	2·750	2·651	3·418	3·724	2·178	2·207	4·124	4·326	4·183	42·366
1873	4·438	1·422	3·631	0·595	2·641	1·172	4·140	3·784	2·914	3·887	2·734	0·711	32·069
1874	3·927	2·399	2·144	1·988	0·663	1·061	1·558	4·637	7·071	3·825	2·358	3·617	35·248
1875	5·144	2·248	1·455	2·091	2·867	3·525	5·991	1·785	4·599	6·977	6·085	1·280	44·047
1876	2·623	4·871	4·049	3·071	0·227	0·929	1·638	4·715	5·353	3·395	4·582	6·962	42·415
1877	4·599	2·376	2·451	2·977	2·213	1·182	3·136	5·186	2·873	3·103	5·932	2·202	38·230
1878	1·579	1·836	2·313	2·952	5·857	3·166	2·033	4·221	2·923	5·958	3·138	2·043	38·019
1879	4·307	3·921	1·102	2·863	3·218	5·145	3·669	7·319	3·906	1·276	0·586	1·345	38·657
1880	0·658	4·519	2·639	2·397	1·244	2·447	4·831	0·409	3·661	5·997	3·095	5·476	37·373
1881	1·714	3·838	1·935	0·612	1·516	3·550	2·469	5·635	2·100	2·262	4·323	4·152	34·106
1882	2·718	2·438	2·294	4·068	1·928	3·372	6·180	5·177	2·696	7·135	5·819	4·455	48·280

TABLE II.

EXTREMES OF MONTHLY AND ANNUAL RAINFALL, 1853—1882.

	Least Fall.		Greatest Fall.	
	Depth.	Date.	Depth.	Date.
	In.		In.	
January	0·311	1855	6·416	1872
February	0·413	1862	4·871	1876
March	0·544	1853	4·865	1867
April	0·022	1854	4·068	1882
May	0·227	1876	6·364	1869
June	0·619	1870	7·104	1860
July	0·509	1863	6·180	1882
August	0·409	1880	8·508	1865
September	0·022	1865	7·404	1866
October	1·276	1879	7·135	1882
November	0·541	1855	6·085	1875
December	0·607	1853	6·962	1876
Year	22·746	1864	48·280	1882

TABLE III.

MEANS OF MONTHLY AND ANNUAL RAINFALL, 1853—1882.

	Mean of 1st 10 years.	Mean of 2nd 10 years.	Mean of 3rd 10 years.	Mean of the 30 years.
	In.	In.	In.	In.
January	2·505	4·078	3·171	3·251
February	1·360	2·608	2·987	2·318
March	2·262	1·983	2·401	2·216
April	2·109	1·962	2·361	2·144
May	2·628	2·221	2·237	2·362
June	3·197	2·119	2·555	2·623
July	2·984	2·328	3·564	2·959
August	3·298	3·201	4·287	3·595
September	2·885	3·369	3·810	3·355
October	3·526	3·471	4·382	3·793
November	2·157	2·546	3·865	2·856
December	2·109	3·190	3·224	2·841
Year	31·020	33·076	38·844	34·313

The last column in Table III. shows the average rainfall in each of the twelve months and in the entire year. The average annual fall will be seen to be 34·313 inches. A comparison of this amount with the annual average of other stations would be interesting, but does not fall within the scope of the present article. Examining the monthly averages, we find that the driest month of the year is April, with 2·144 inches; the wettest, October, with 3·793 inches. From April to October there is an almost unbroken rise, the only interruption to the order being that August is somewhat wetter than September. From October to April the sequence is less regular. It is worthy of note that the three driest months—February, March, and April—occur consecutively and that the three wettest months—August, September, and October—also occur consecutively. Speaking generally, the spring is the dry time of the year, the autumn the wet time.

The three first columns of Table III. tell a very remarkable story. They present the average rainfall of the several months and of the year, derived from each of the three decades composing the 30 years. As regards the months, the discrepancies between the three columns are not perhaps surprising, although it may be worth while to point out that the average of February derived from the third ten years is considerably more than double the average of the same month derived from the first ten years. The annual results, however, are not a little singular, showing as they do a progressive increase in the quantity of rain. Between the first and second decades there is an increase of over two inches, between the second and third an increase of nearly six inches, the annual average derived from the ten years ending with 1882 being thus nearly eight inches in excess of that derived from the ten years ending with 1862.

Different persons will draw from these facts different conclusions. To some they may appear to indicate a law of increase in the rainfall, which will show itself in the future as in the past. Others will incline to regard the abnormally rainy character of recent years as nothing more than a fluctuation, to be compensated shortly by a series of years equally remarkable for dryness. Either conclusion would be rash. A succession of wet years may with equal reason be considered as a compensation for previous drought, or as itself demanding a compensation in years to come, and in reality gives little or no clue to the future. On the other hand, it may be safely asserted that if any law of progressive increase of rainfall really exists, the evidence of such law must be sought in the records of a far longer period than the thirty years now under discussion. The secular variation of rainfall is a question second to none in meteorology for interest and practical importance. It has been investigated laboriously by Mr. G. J. Symons,[1] who for this purpose has availed himself of records reaching back for more than a century and a half. Within this period extraordinary variations have occurred. Thus, the ten years 1740—49 show an intensity of drought to which there has been no subsequent approach. On the other hand, for excess of rain, the ten years just passed are equally without a parallel. These facts, while not inconsistent with the theory of a permanent increase in the fall of rain, are by no means in themselves conclusive. They rather suggest the expediency of deferring judgment until another hundred years or so shall have passed, by which time it is possible that the drought of 1740—49 may have repeated itself, and the whole aspect of the question be changed. Meanwhile, it may be interesting to quote some results obtained by Mr. George Dines[2] in discussing observations of rainfall in the neighbourhood of London during the last 70 years. The mean annual rainfall of the whole period being taken as 100, and the 70 years being divided into seven decades, the proportion of the mean annual fall of each decade to the mean of the 70 years will be seen in the following table:—

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[1] *British Rainfall*, passim.

[2] *The Times, March 27, 1883.*

Decade.	Proportional Rainfall.
1813—22	103
1823—32	101
1833—42	95
1843—52	98
1853—62	95
1863—72	100
1873—82	108

It further appears that if the whole period of 70 years be divided into two periods of 35 years each, the mean annual rainfall of the first of these periods will be represented by 99, and that of the second by 101.

Of the diagrams, it is only necessary to say that the first is a graphic representation of the last column in Table I., and the second a similar representation of the last column in Table III.

Meteorological Observations, as regards Temperature, taken at Clifton,

1881, 1882.

By H. B. JUPP, M.A., F.M.S.

THE observations from which the following tables are derived have been taken at 9 a.m. daily, at Clifton College.

1881 TEMPERATURES.

MONTH.	Maximum in Shade.		Minimum in Shade.		Mean in Shade.	Minimum on Ground, Lowest recorded.
	Highest recorded.	Mean.	Lowest recorded.	Mean.		
January ...	49·1	36·44	12·3	27·10	31·77	5·8
February ...	52·1	43·26	27·5	35·33	39·30	20·4
March ...	55·9	48·76	25·2	37·17	42·96	18·6
April	63·6	54·78	28·5	39·88	47·33	23·5
May	72·8	62·95	33·7	45·95	54·45	27·3
June	78·3	64·52	38·3	49·21	56·87	35·7
July	86·9	74·55	45·4	57·21	65·89	39·6
August ...	78·6	65·48	44·0	52·05	58·77	40·5
September ..	71·7	63·63	43·6	49·61	56·62	38·1
October ...	66·8	52·88	26·9	40·04	46·48	20·8
November ..	59·2	52·66	28·9	44·05	48·35	24·8
December...	53·5	45·02	25·4	36·52	40·77	19·8
The Year ...	86·9	55·44	12·3	42·92	49·18	5·8

Meteorological observations being now taken regularly at Clifton College, Mr. Jupp has kindly undertaken to put the data concerning the temperature of Clifton into suitable form for publication, as it is considered that their local importance will make them interesting to the Members of the Society. It is proposed to publish a similar account yearly in future.

MONTH.	Number of Days on which the Minimum Ground Temperature was below 32°.	Number of Days on which the Minimum Air Temperature was below 32°.	Number of Days on which the Maximum Air Temperature was below 32°.	Number of Days on which the Mean Air Temperature was below 32°.
January ...	26	20	11	20
February ...	14	11	0	2
March ...	14	8	0	1
April	11	8	0	0
May	1	0	0	0
October ...	7	3	0	0
November ..	4	1	0	0
December ...	17	9	0	1

On ten days the minimum temperature of the ground was above that of the air, viz., January 10th, both thermometers A and G rising—March 17, A falling, G rising—April 25th, A falling, G rising—June 12th, A falling, G stationary; 18th, both rising; 21st, A stationary, G rising; 14th, both rising; 16th, both rising; 31st, A falling, G stationary—October 25th, both falling.

(A) indicates thermometer in the air; (G) indicates thermometer on the ground.

Snow lay on the ground from the 15th to 29th of January.

1882 TEMPERATURES.

MONTH.	Maximum in Shade.		Minimum in Shade.		Mean in Shade.	Minimum on Ground, Lowest recorded.
	Highest recorded.	Mean.	Lowest recorded.	Mean.		
January ...	53·2	44·84	28·6	36·50	40·67	24·1
February ...	53·7	46·91	30·4	38·28	42·59	26·2
March ...	61·5	52·28	30·1	39·16	45·72	25·9
April	63·5	55·79	33·0	41·87	48·83	30·2
May	67·6	61·79	37·1	45·71	53·75	33·6
June	71·3	62·35	41·6	49·74	56·04	38·6
July	73·8	65·99	49·2	53·40	59·65	47·1
August ...	78·5	67·35	45·2	53·04	60·20	41·5
September ..	65·5	61·06	37·9	46·76	53·91	35·5
October ...	67·5	55·74	33·6	44·71	50·23	31·6
November ..	59·4	49·12	29·2	38·24	43·68	24·3
December...	53·8	42·93	21·9	36·70	39·81	20·6
The Year ...	78·5	55·46	21·9	43·62	49·54	20·6

MONTH.	Number of Days on which the Minimum Ground Temperature was below 32°.	Number of Days on which the Minimum Air Temperature was below 32°.	Number of Days on which the Maximum Air Temperature was below 32°.	Number of Days on which the Mean Air Temperature was below 32°.
January ...	8	4	0	0
February ...	12	3	0	0
March ...	11	5	0	0
April	5	0	0	0
October ...	1	0	0	0
November ..	11	3	0	0
December...	15	11	2	7

The minimum ground temperature (G) was higher than the minimum air temperature (A) on fifteen days, viz., January 17th, 18th, 19th, when both thermometers were falling—June 9th, G rising, A falling—July 2nd, ditto, ditto; 17th, both falling; 29th, ditto—August 15th, ditto; 19th, G rising, A falling—September 17th, G rising, A stationary—October 1st, both rising; 11th, G rising, A falling; 14th, both rising—November 1st, G rising, A falling; 2nd, both rising.

The First Telephone.

By Professor SILVANUS P. THOMPSON.

FOUR days after the foundation of the Bristol Naturalists' Society, that is to say, on the 12th of May, 1862, there was met together in a fine old hall in the City of Frankfort-on-the-Main a crowded audience, eager to see and hear the latest scientific invention expounded by its inventor. The occasion was the meeting of the Free German Institute (Freies Deutsches Hochstift), a sort of Literary and Philosophical Society, which has since domiciled itself in the historical old house where Goethe was born. The invention which attracted so notable a crowd was the Telephone. The inventor was Philipp Reis, a teacher of natural sciences in Garnier's Institute, a flourishing boys' school at Friedrichsdorf, near Homburg.

On one occasion previously had the Telephone been publicly exhibited; namely, at a meeting of the Physical Society of Frankfort, on the 22nd of October in the preceding year.

In the Journal of the Frankfort Society (Jahresbericht des Physikalischen Vereins zu Frankfurt am Main) for 1860-61, p. 57, may be found the memoir of Philipp Reis on the subject, under the title "On Telephony by the Galvanic Current." In this memoir, which shows a marvellous precision and a grasp of the subject that excites admiration and wonder, the author says: "I have now succeeded in constructing an apparatus by means of which I am in a position to re-produce the tones of divers instruments, and even to a certain degree the human voice." The inventor further says:—"Since the length of the conducting wire may be extended for this purpose just as far as in direct Telegraphy, I give to my instrument the name 'Telephone.'" Toward the end of the memoir it is stated that until now it had not been possible to reproduce the tones of human speech with a distinctness sufficient to satisfy everybody; adding: "the consonants are for the most part tolerably distinctly reproduced, but the vowels not yet to an equal degree." The author of the memoir in which these statements occur had been led to his invention by a remarkably suggestive line of thought. He had wanted an instrument to transmit electrically everything and anything that a human ear could hear. Accordingly he took the human ear itself as a model. "How," he argues, "could a single instrument reproduce at once the total actions of all the organs operated in human speech? This was ever the cardinal question. At last I came by accident to put this question another way: How does *our ear* perceive the total (or resultant) vibrations of all the simultaneously-operant organs of speech?" He then goes on to describe the action of the auditory ossicles when the ear is made the recipient of sound; pointing out how they execute movements and exert forces upon one another in proportion to the condensations occurring in the sound-conducting medium and to the amplitudes of vibration of the tympanum. Having stated this law of proportion between the cause and its effect he goes on to speak of the graphic method of representing varying forces, such as those of sound-waves, by curves; and emphatically lays down that the ear is absolutely incapable of perceiving anything more than can be expressed by such a curve. After giving samples of undulatory curves corresponding to musical and to discordant sounds, he makes the following significant remark:—"So soon, therefore, as it is possible at any place and in any manner, to set up vibrations whose curves are like those of any given tone or combination of tones, we shall then receive the same impression which the tone or combination of tones would have produced upon us. Taking my stand upon the preceding principles, I have succeeded in constructing an apparatus," &c. He concludes his paper by saying that the newly-invented Phonautograph of Duhamel may perhaps afford evidence as to the correctness of the views which he has asserted respecting the correspondence between sounds and their curves.

The actual apparatus figured in this memoir, and exhibited to the Frankfort Society in October, 1861, is now in my possession; and I have also temporarily entrusted to me a still earlier experimental telephone, made by Philipp Reis, in the form of a model of the human ear.[1] This interesting instrument is depicted in its actual condition and size in Figures, 1, 2, and 3, and in section in Fig. 4.

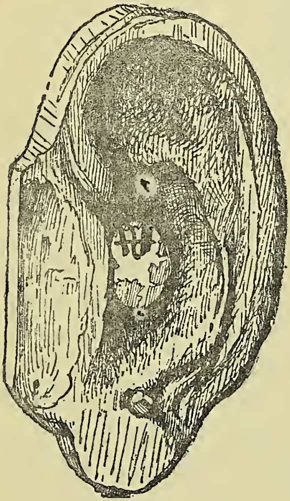

Fig. 1.

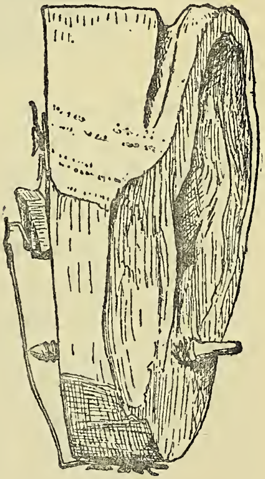

Fig. 2.

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[1] The property of Léon Garnier, Esq., Director of Garnier's Institute at Friedrichsdorf, near Homburg, where Philipp Reis was formerly teacher of Natural Sciences.

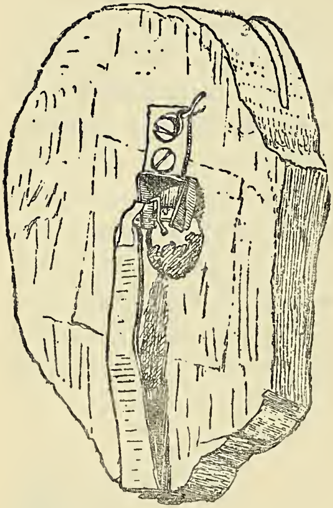


Fig. 3.

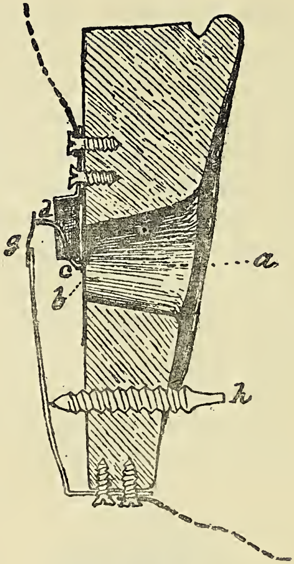


Fig. 4.

It is carved in oak-wood. Of the tympanic membrane only small fragments now exist. Against the centre of the tympanum rested the lower end of a little curved lever of platinum wire, which represented the "hammer" bone of the human ear. This curved lever was attached to the membrane by a minute drop of sealing-wax, so that it moved in correspondence with every movement of the tympanum. It was pivotted near its centre by being soldered to a short cross-wire serving as an axis. The upper end of the curved lever rested in loose-contact against the upper end of a vertical spring, about one inch long, bearing at its summit a slender and resilient strip of platinum foil (see Fig. 4). An adjusting screw served to regulate the degree of contact between the vertical spring and the curved lever. Conducting wires by means of which the current of electricity entered and left the apparatus were affixed to screws in connexion respectively with the support of the pivotted lever and with the vertical spring. A springy strip of platinum pressed against the end of the pivot of the lever (as shewn enlarged in fig. 5) to ensure good electrical contact.

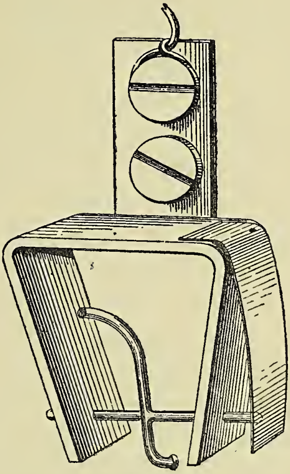


Fig. 5.

If now any words, or sounds of any kind, were uttered in front of the "ear," the membrane was thereby set into vibrations as in the human ear. The little curved lever took up these motions precisely as does the "hammer"-bone of the human ear; and, like the "hammer"-bone, transferred them to that with which it was in contact. The result was that the contact between the upper end of the lever and the spring was caused to vary. With every rarefaction of the air the membrane moved forward, and the upper end of the little lever moved backward, and pressed more firmly than before against the spring, making better contact, and allowing a stronger current to flow. At every condensation of the air the membrane moved backwards and the upper end of the lever moved forward, so as to press less strongly than before against the spring, thereby making a less complete contact than before; and, by thus partially interrupting the passage of the current, caused the current to flow less freely. The sound-waves which entered the air would in this fashion throw the electric current, which flowed through the point of variable contact, into undulations in strength. Reis himself termed the contact-part of his Telephone an "interruptor." That it was not intended to operate as an abrupt make-and-break arrangement, as some persons have erroneously fancied is evident; firstly, because the inventor introduced delicate springs to give a following-contact (like that in Blake's well-known "transmitter"), and so prevent abrupt breaks from occurring; secondly, because abrupt breaks would have violated the fundamental principle to which he refers in the sentence immediately preceding his description of the instrument shewn to the Frankfort Society, namely that of creating tones whose curves were like the undulatory curves imparted at the transmitting end of the instrument; thirdly, because (in another article) he described his instruments as opening and closing the circuit in proportion to the sound-wave; which obviously an abrupt "break-and-make" apparatus without a spring-contact could not possibly do. The mechanism which Reis thus invented —and which is substantially alike in all his instruments—might be appropriately described as the combination of a tympanum with an electric current-regulator; the essential principle of the electric current-regulator being the employment of a loose or imperfect contact between the two parts of the conducting system; those parts being so arranged that the vibrations of the tympanum would alter the degree of contact, or occasion an approach and recession of the atoms of the two surfaces, and so vary the resistance offered at the point of contact to the flow of the current.

The particular form of the instrument shewn at Frankfort in 1861, and described in the Journal, is somewhat different from the "ear." The description is taken from the Journal.

"In a cube of wood there is a conical hole, closed at one side by the membrane (made of the lesser intestine of the pig), upon the middle of which a little strip of platinum is cemented as a conductor of the current. This is united with the binding-screw *p*. From the binding-screw *n* there passes likewise a thin strip of metal over the middle of the membrane, and terminates here in a little platinum wire which stands at right-angles to the length and breadth of the strip. From the binding-screw *p* a conducting wire leads through the battery to a distant station." In the original instrument there is also an adjusting-screw to regulate the contact, though this was not shewn in the drawing in the Frankfort Journal.

The receiver used to reproduce the sounds transmitted by these Telephones is also described in the memoir of Reis. It consisted of a steel needle surrounded by a coil of wire. This was at first set up—for the purpose of increasing the sounds by resonance—upon the top of a violin, as shewn in fig. 6; later it

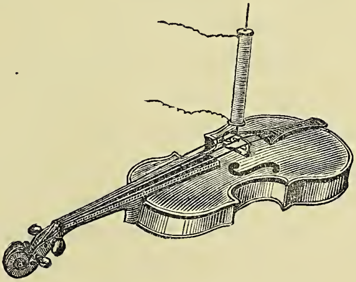


Fig. 6.

was mounted upon a pine-wood box, as in fig. 7; to which still

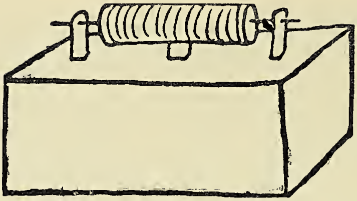


Fig. 7.

later a lid of thin pine was added, against which the listener could press his ear. The sounds emitted by such a wire during magnetisation and demagnetisation were well-known before, but to Reis is due the discovery that other tones than the natural vibration-tone of the wire could be electrically imposed upon it by the varying magnetising power of the current traversing the surrounding coil. Reis explained the reproduction of the transmitted sounds by supposing a magnetic attraction between the atoms of the steel wire to work synchronously with the fluctuations of the current. He later devised a different receiver in which an electromagnet was provided with an elastically-mounted armature of iron attached to a light and broad lever, which it threw into vibrations corresponding to those of the original sound-waves. With this apparatus, and a transmitter with a small curved-lever, in shape like that in the "ear," he was able (see Kuhn's "Handbuch der Angewandten Elektricitätslehre," 1866, p. 1021), not only to reproduce melodies with astonishing exactness, and single words as in speaking and reading less distinctly, but even to transmit the inflexions of the voice expressive of surprise, command, interrogation, &c.

Considering how far these early researches were carried, it is remarkable that their historic value has been so greatly overlooked. The transmitters which Reis devised embody—though their mechanical design is less perfect and their performance consequently less certain—all the essential principles of the telephonic transmitters in use to-day, such as Blake's, Berliner's, and Crossley's. The receivers devised by Reis, more particularly the second form, anticipate every principle essential in the more modern and convenient receiver of Graham Bell, having an electromagnet combined with an armature capable of inductive action, *i. e.*, made of iron, elastically mounted, and having an extended surface. Bell made the very great improvement of uniting these three qualities, essential to the armature, in one, by employing as armature a thin flexible iron plate. It is but just to the later inventors to add that both Bell and Edison have explicitly referred to Reis's prior work, Bell even going so far as to name the pages of Kuhn's Handbook from which the preceding reference is taken.

The Fungi of the Bristol District.

PART VI.

BY CEDRIC BUCKNALL, Mus. Bac.

LEPIOTA.

935. Agaricus granulosus, *Batsch.* Hanham, Oct. 1882.

A white variety.

* Agaricus amianthinus, *Scop.* Leigh Down.

This was referred to *Ag. granulosus* at Vol. II., p. 208.

935A. Agaricus citrophyllus,
B. & Br.? Leigh Wood, Sept. 1882.

Pileo obtuso v. late umbonato demum depresso citrino squamulis variis rufis obsito ; stipite citrino e farcto cavo squamuloso ; lamellis ventricosis postice rotundatis v. attenuatis approximatis citrinis. There are several forms of this species. *B. & Br. Ceylon Fungi in Linn. Soc. Jour.*

A *Lepiota* has occurred in Leigh Wood which answers well to the above description, and also agrees with drawings by Dr. Thwaites in the Herbarium at Kew. If *Ag. citrophyllus* were not exotic, I should have no hesitation in referring my plant to that species. Two varieties were found, one entirely yellow with reddish-brown scales, and the other reddish-brown with white gills. It is possible that they are two of the varieties figured by Dr. Thwaites, although my impression at the time was that they were distinct. The yellow variety smelt like *Ag. cristatus.* The spot where they grew was singularly rich in small species of *Lepiota*, *Ag. Bucknalli*, *Ag. granulosus var. rufescens*, and *Ag. seminudus* growing within a few yards, under the same hawthorn bush.

TRICHOLOMA.

936. Agaricus sejunctus, *Fr.* { Blaize Castle Wood, Sept. 1882.

Mycena.

937.	Agaricus fagetorum, *Fr.*	Nibley Knoll,	Oct. 1883.

Slender, thin; pileus even, striate to the middle; stem subincurved at the villous base, affixed to leaves; gills nearly free, attenuated behind, uncinate, joined to a collar. Livid to whitish with white gills, or fuligineous with glaucous gills. *Fr. Hym. Eur., p. 138.*

Rooting amongst moss, on the border of a beech wood. Described by Fries as a form of *Ag. excisus*, but Dr. Cooke considers it to be a distinct species.

938.	Agaricus aetites, *Fr.*	Hanham,	Oct. 1882.
939.	,, setosus, *Sow.*	Blaize Castle Wood,	Oct. ,,

Omphalia.

940.	Agaricus abhorrens, *B. & Br.*	Tyntesfield,	Nov. ,,
941.	,, umbelliferus, *L.*	Black Down, (Mr. White,)	May, ,,
942.	,, pseudoandrosaceus, *Bull.*	Leigh Wood,	Nov. 1880.
943.	Agaricus stellatus, *Fr.*	,,	Nov. 1882.
944.	,, griseus, *Fr.*	Blaize Castle Wood, Hanham,	Oct. ,,

Pleurotus.

945.	Agaricus ulmarius, *Bull.*	Durdham Down,	Autumn, 1882.

Entoloma.

946.	Agaricus jubatus, *Fr.*	Hanham,	Oct. ,,
947.	,, griseo-cyaneus, *Fr.*	Leigh Down,	July, ,,

Eccilia.

948.	Agaricus Parkensis, *Fr.*	Penpole Point,	July, ,,

Pholiota.

949.	Agaricus ombrophilus, *Fr.*	Blaize Castle Wood,	Aug. ,,

Inocybe.

950.	Agaricus descissus, *Fr.* ?	Leigh Wood,	Aug. 1880.

STROPHARIA.

951.	Agaricus stercorarius, *Fr.*	Aust,	June,1881.

HYPHOLOMA.

952.	Agaricus hydrophilus, *Bull.*	Tyntesfield,	July, 1882.

PSILOCYBE.

953.	Agaricus semilanceatus, *Fr.*	Durdham Down,	Sept. 1879.
954.	Cortinarius (Dermocybe) sanguineus, *Fr.*	Blaize Castle Wood,	Oct. 1882.
955.	Cortinarius (Telamonia) scutulatus, *Fr.*	,,	Sept. ,,
*	Cortinarius (Telemonia) paleaceus, *Weinm.* var.	,,	Oct. ,,

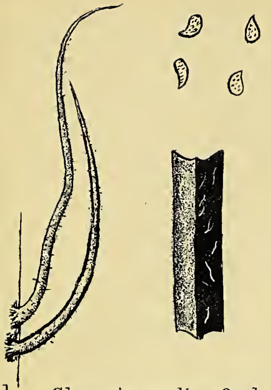
Dr. Cooke considers that my specimens, which were of a bright brown colour, are the form alluded to by Fries as Secretan's No. 138.

956.	Cortinarius (Hydrocybe) rigens, *Fr.*	Blaize Castle Wood,	Oct. 1882.
957.	Paxillus panaeolus, *Fr.*	,,	Sept. ,,

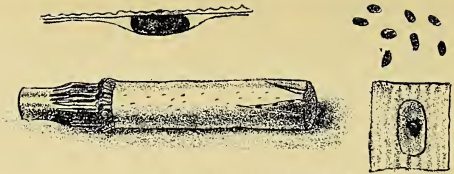
An interesting addition to our British fungi.

958.	Hygrophorus fornicatus, *Fr.*	Durdham Down,	Oct. ,,
959.	,, ovinus, *Fr.*	,,	Oct. ,,
960.	,, Houghtoni, *B. & Br.*	Hanham,	Oct. ,,
961.	Hygrophorus miniatus, *Fr.*	,,	Oct. ,,
962.	,, murinaceus, *Fr.*	Durdham Down,	Oct. ,,
963.	Marasmius porreus, *Fr.*	Westridge Wood,	Oct. ,,
964.	,, Hudsoni, *Fr.*	Clevedon (Mr. Wheeler),	Winter, ,,
965.	Odontia fimbriata, *P.*	Leigh Wood,	Nov. ,,
966.	Clavaria coralloides, *L.*	Tyntesfield,	Nov. ,,
967.	,, formosa, *P.*	Durdham Down,	Oct. ,,
968.	,, aculina, *Quelet.*	Boiling Wells,	June, ,,

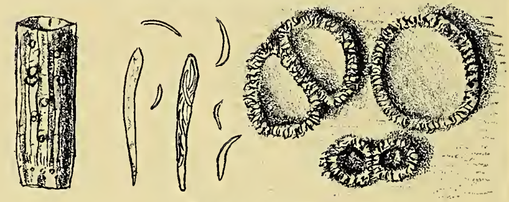
Small, horn-shaped, incurved, oblique, swollen and villous at the base, pruinose, white, terminated by a very acute, hyaline point.



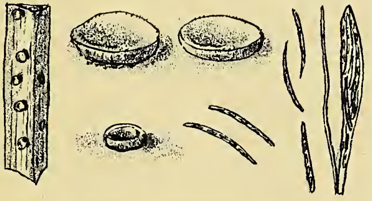
1.— *Clavaria aculina*, Quel.



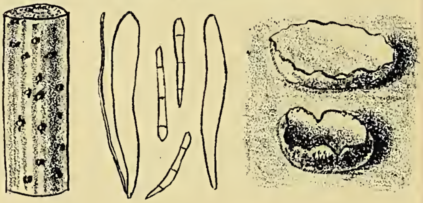
2.— *Phoma equiseti*, Lev.



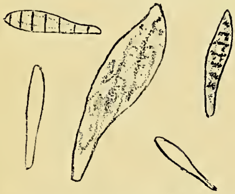
3.— *Peziza prasina*, Quel.



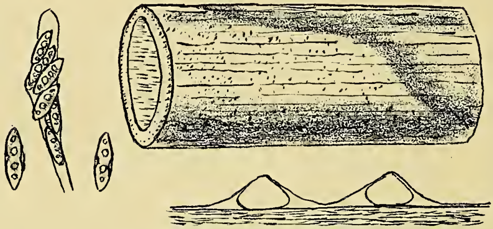
4.— *Peziza excelsior*, Karst.



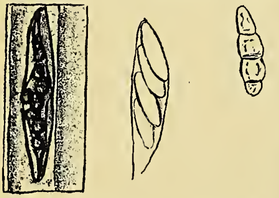
5.— *Peziza Arctii*, Phill.



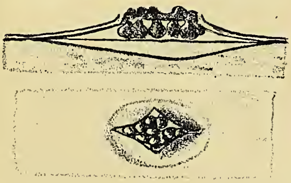
6.— *Stictis pteridina* Phill. & Buck.

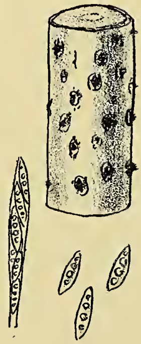


7.— *Nectria dacrymycella*, Nyl.

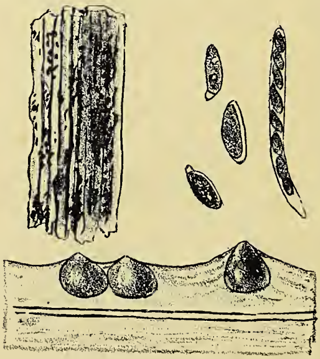


8.— *Dothidea caricis*. Fr.





9.— *Valsa pustula*, Desm.



10.— *Sphaeria italica*, Sacc.

Spores pruniform elongated (·012 m.m.), hyaline. *Quel. Assoc. Fran., 1880.*

On dead leaves of *Carex* in a marsh. Plant $\frac{1}{10}$ in. high. Spores ovate, apiculate ·0005 in. long. (Fig. 1.)

969. Typhula gyrans, *Fr.*	Durdham Down,	April, 1883.
970. Pistillaria quisquilaris, *Fr.*	Leigh Wood,	April, 1882.
971. Dacrymyces chrysocomus, *Tul.*	Blaize Castle Wood,	Nov. ,,
972. Hydnangium carotaecolor, *Berk.*	Leigh Wood,	Nov. ,,
973. Geaster fimbriatus, *Fr.*	,,	Sept. ,,
974. Didymium microcarpon, *Fr.*	,,	April, 1880.
975. Diachaea leucopoda, *Bull.*	———	———
976. Lamproderma arcyrioides, *Somm.*	Blaize Castle Wood,	Nov. 1882.
977. Perichaena corticalis, *Batsch.*	Leigh Wood,	Nov. ,,
978. Phoma equiseti, *Lev.?*	Leigh Wood,	June, ,,

Perithecia innate, scattered, globose, minute, black inside, covered by the epidermis, ostiola obsolete; spores ovate, pellucid, simple. *Lev. Ann. Sci. 1846, p. 282.*

In my specimens the perithecia are oblong, and the spores brown, oval, binucleate, ·00025 in. long. Mr. Broome has met with the same species, and observes that Leveillé may have described an immature plant, and that the spores might become dark with age. (Fig. 2.)

979. Leptothyrium ribis, *Lib.*	Blaize Castle Wood,	May, 1882.
980. Hendersonia Stephensii, *B. & Br.*	Leigh Down,	May, ,,
981. Neottiospora caricum, *Desm.*	Blaize Castle Wood,	May, ,,
982. Puccinia buxi, *D. C.*	Cleeve Toot,	July, ,,
983. Lecythea saliceti, *Lev.*	Leigh Wood,	July, ,,
984. ,, lini, *Lev.*	Wotton-under-Edge (Mr. White),	July, ,,

985.	Volutella setosa, *Berk.*	Westridge Wood,	Oct. 1882.
986.	Arthrobotryum atrum, *B. & Br.*	Leigh Down,	May, ,,
987.	Psilonia gilva, *Fr.*	Blaize Castle Wood,	May, ,,
988.	Sporodinia dichotoma, *Corda.*	Westridge Wood,	Sept. 1881.
989.	Endogone pisiformis, *Lk.*	Leigh Wood,	May, 1883.
990.	Erysiphe Montagnei, *Lev.*	Blaize Castle Wood,	Aug. 1882.
991.	Geoglossum viride, *Pers.*	Tyntesfield,	Nov. ,,
992.	,, glutinosum, *Pers.*	Hanham,	Oct. ,,
993.	Peziza rutilans, *Fr.*	,,	Oct. ,,
994.	,, violascens, *Cooke.*	Leigh Wood,	Aug. ,,
995.	,, pygmaea, *Fr.*	,,	July, ,,
996.	Peziza nivea, *Fr.*	,,	June, ,,
997.	,, prasina, *Quelet.*	Cheddar,	June, ,,

Cup discoid (1 m.m.—1, 5), sessile, thin, waxy, soft, olivaceous, bristling with flexuous, hyaline then fiery-red hairs, hymenium plane, greenish-brown then of a beautiful green, at length becoming pale. Spores fusiform, curved, ·012 m.m. *Quel. Assoc. Fran. 1880.* On dead stems of *Phalaris arundinacea.* (Fig. 3.)

998.	Peziza excelsior, *Karst.* (Fig. 4.)	Boiling Wells,	June, 1882.
999.	Peziza (Mollisia) Arctii, *Phill.* n. s.	Blaize Castle Wood, Leigh Wood,	May, ,, May, 1883.

Minute, scattered, sessile, at first subglobose, then expanded, the paler, serrated margin erect or connivent, externally scalrous; disc same colour; asci broadly clavate; sporidia 8, linear-lanceolate, triseptate, biseriate, ·03—·045 × ·003—·005 m.m.; paraphyses linear, stout.

On *Arctium Lappa*—on the dead stems. (Fig. 5.)

1000.	Helotium salicellum, *Fr.*	Leigh Wood,	April, 1882.
1001.	Ascobolus denudatus, *Fr.*	Leigh Down,	June, ,,
1002.	Stictis pteridina, *Phill. & Buck.* n. s.	Leigh Wood,	Mar. ,,

Scattered, slightly immersed, circular or elongated, irregular, open; disc pallid-brown, not deeply depressed; margin membranaceous; asci broadly clavate; sporidia 8, biseriate, clavate or clavato-fusiform, six to seven times pseudo-septate, or muriform, ·028—·044 × ·005—·009 m.m.; paraphyses adherent.

The sporidia are remarkable, and with the other characters readily distinguish this from all described species.

On *Pteris aquilina*. (Fig. 6.)

1003.	Elaphomyces granulatus, *Fr.*	Leigh Wood,	Nov. 1882.
1004.	Phacidium ranunculi, *Desm.*	Stoke,	Oct. ,,
1005.	Lophium fusisporum, *Cooke.*	Leigh Down,	June, ,,
1006.	Nectria Russeliana, *Mont.*	Cleeve Toot,	July, ,,
1007.	,, dacrymycella, *Nyl.*	Blaize Castle Wood,	May, ,,

On a dead stem of *Angelica sylvestris*. Forming large reddish patches, at first sight resembling *Peziza fusarioides*. When moist the patches are surrounded by a broad yellow line. (Fig. 7.)

1008.	Dothidea caricis, *Fr.*	Blaize Castle Wood,	May, 1882.

The fruit is undescribed in Cooke's "Handbook," and was immature in my specimens. Asci broadly oblong ·0024 in.; sporidia oblong, apparently becoming 3 or 4 septate, ·001 in. long. (Fig. 8.)

1009.	Diaporthe velata, *Pers.*	Leigh Wood,	April, 1882.
1010.	,, Laschii, *Nke.*	,,	May, 1883.
1011.	,, Euphorbiae, *Cooke.*	,,	May, ,,
1012.	Valsa tiliae, *Tul.*	,,	May, 1881.
1013.	,, pustulata, *Desm.*	,,	June, 1882.

Erumpent, pustulate, scattered, stroma cortical, circumscribed with a pallid line; disc black, subconvex, perithecia 4—7 crowded in the centre; ostiola rather prominent, subumbilicate; asci large ($\frac{1}{15}$ m.m.); sporidia fusiform, 4-nucleate ($\frac{1}{70}$m.m.). *Desm. Ann. Sci. Nat. 1846, p. 71.* On dead branches of sycamore. (Fig. 9.)

1014.	Cucurbitaria berberidis, *Gray.* (Spermogonia)	Brockley,	July, 1882.
1015.	Lophiostoma angustilabra, *B. & Br.*	Leigh Wood,	April, ,,

1016.	Psilosphaeria Stevensoni, *B. & Br.*	Stapleton,	June, 1882.
1017.	Lasiosphaeria innumera, *B. & Br.*	Blaize Castle Wood,	Spring, ,,
1018.	Sphaeria (Anthostoma) italicum, *Sacc. Syl., No.* 1107. (Fig. 10.)	Clevedon, (Mr. Green).	———
1019.	Sphaeria ditopa, *Fr.*	Pensford,	June, 1881.
1020.	,, phaeosticta, *Berk.*	Blaize Castle Wood,	May, 1882.
1021.	,, Ogilviensis, *B. & Br.*	Leigh Wood,	June, ,,

On dead stems of *Solidago virgaurea.* Rabenhorst has published this species, also on *Solidago*, in *Fungi Eur., No. 946*, as *Sphaeria planiuscula.* The sporidia in the latter species are quite different, being 1-septate and only ·0006 in. long, while in *Sphaeria Ogilviensis* they are, when quite mature, 5-septate and ·0022 in. long.

1022.	Sphaeria rubelloides, *Plow.*	Cheddar,	June, 1882.
1023.	,, culmifraga, *Fr.*	,,	June, ,,

Reports of Meetings.

GENERAL.

AT the first meeting of the Session, 1882—3, held on October 5th, papers were read by Mr. T. Morgans, C.E., and by Professor H. S. Hele Shaw. Mr. Morgans' paper was on " Steel." A *resumé* was given of the principal methods of preparing steel from iron, and the author pointed out in what respects our information on this subject is still somewhat defective. At a subsequent meeting Mr. Morgans showed a specimen of blister steel, which exhibited a peculiar arrangement of the blisters. Professor Shaw then gave an account of the proposed bridge over the Firth of Forth. He showed diagrams of its construction, kindly lent for the purpose by Mr. Baker, but as it is not possible to reproduce these here, it would perhaps be unprofitable to give a lengthy description of the paper. We may, however, refer our members to the " Report of the British Association," 1882, p. 419, for a full account of the bridge, which has appeared since Professor Shaw read his report.

At the second meeting, in November, Mr. A. M. Worthington described his apparatus for observing the splash of a drop. This is printed in full, with a diagram, in the present Part.

At the meeting on December 7th, Mr. Barrett Roué, M.D., read a paper on " Comets and Comet-seeking." The subject was treated somewhat exhaustively from an historical point of view, special reference being made to the probable constitution of comets, including the views of the earliest and most recent theorizers on this subject, and the paper concluded with descriptions of some of the most remarkable comets of recent times.

On January 4th, 1883, Dr. Markham Skerritt gave an account of "Recent Investigations in connection with the Germ Theory." After referring to the experiments by which Professor Tyndall showed that air, free from solid particles, was incapable of producing life in organic fluids, he gave details of the observations of Pasteur, Koch, and others, which have established that peculiar organisms are constantly found in the blood of patients suffering from Splenic Fever, Relapsing Fever, Tubercular Disease, &c., which organisms are suspected to be the means by which these diseases are carried from individual to individual. Dr. Skerritt then proceeded to an account of the experiments of Pasteur, in which, by a system of culture, he was able so to modify the nature of these organisms that they could only propagate disease in moderated forms.

On February 1st, the President showed a specimen of the rose of Jericho, and also read a paper on "Thirty Years' Rainfall at Clifton." This paper will be found in another part of the present number of the Proceedings, as will also a paper by Mr. E. Wethered, F.C.S., on "Sources of Water Supply," which was read at the same meeting, and is of considerable local interest.

On March 1st, Mr. J. G. Grenfell made a communication on "Evolution in the Protozoa." "The object of the paper was to give an illustration of the interesting problems presented by the theory of evolution with special reference to the principle of utility which is implied in the doctrine of the survival of the fittest." Taking the lines of the probable evolution of the Protozoa, as established by Saville Kent and others, Mr. Grenfell showed the amount of structural difference which exists between the various groups, and applied the principle of utility to explain how these changes may have originated. In the *Amœba* we have an almost structureless mass of protoplasm endowed with the power of putting forth long root-like limbs, and potentially endowed with the power of secreting various substances. Mr. Grenfell suggested that the first change probably would be the production of a race of swimming *Amœbæ* due to an undulatory motion given to one of the long root-like feet. When this foot is reduced in thickness, and its rate of motion is increased, we reach the group of the *Rhizo-flagellata.* The power of swimming may then have led to the disuse of the root-feet, and to the assumption of an elongated form better adapted for swimming. These creatures form the lowest group of the true *Infusoria.* The evolution of the *Infusoria* was traced in a similar way, and Mr. Grenfell pointed out that among the highest forms there are distinct foreshadowings of some of the chief organs of the higher animals. The paper was illustrated by numerous diagrams. It produced considerable discussion.

To the last ordinary meeting of the session, held on April 5th, Mr. H. Charbonnier sent a notice of Ridgway's "Catalogue of American Birds," which is printed in full. At the same meeting Dr. Ramsay read a paper on "Water," in which he dealt chiefly with the impurities with which it is liable to be contaminated, and the means of detecting them. These points were illustrated by experiments and by lantern slides.

CHEMICAL AND PHYSICAL SECTION.

THE Section has met five times since the last report, and a number of papers have been read, two of which are printed in the Proceedings. The following are the names of the members who have read papers during the Session:—Professor Ramsay, Professor S. P. Thompson, J. E. Pearson, W. A. Shenstone, A. M. Worthington, and Sidney Young; and Messrs. F. J. Fry and M. W. Dunscombe have exhibited objects of interest at the meetings.

W. A. SHENSTONE, *Hon. Sec.*

BOTANICAL SECTION.

THIS Section has met as usual and has contributed a paper to the Proceedings. There is nothing further to report.

J. W. WHITE, *Hon. Sec.*

GEOLOGICAL SECTION.

THIS Section had meetings on March 16th, April 3rd, Nov. 30th, and Dec. 29th, 1882, at which papers were read by the President (Professor Sollas), Messrs. E. Wethered and Montague Smith.

On April 1st an excursion was made to Bradford-on-Avon and Devizes.

At Whitsuntide a very enjoyable excursion was made. The party left Bristol on the morning of the 29th of May by train for Yeovil; thence they walked to Bradford Abbas and visited Professor Buckman, who received them with great hospitality and exhibited his collection of fossils. After working at the quarries in the neighbourhood, the party walked on to Sherborne, visited the museum of the Grammar School, and, after dining at the Digby Arms, went by train to Axminster and thence drove to Lyme Regis.

On the 30th they worked in the lias at the cliffs between Lyme and Charmouth, returned to Lyme Regis, and then drove to the landslip and thence to Seaton, then by rail to Chard and thence by road to Ilminster.

On the 31st the party drove about in a break all the day from quarry to quarry, visiting Moolham, Donyate, Barrington, and Shepton Beauchamp, stopped at Jordan's Park and inspected the large collection of curiosities brought home by Speke, then on to South Petherton and Martock, from whence they returned by train to Bristol. This excursion was thoroughly successful and each day very enjoyable. The weather was perfect and the party kept in good spirits by the President, Professor Sollas, who explained all the geological features of the country passed through.

A. C. PASS, *Hon. Sec.*

ENTOMOLOGICAL SECTION.

DURING the summer months only two excursions were taken by the Section—to Leigh Woods in May and Portbury in September. At Leigh no species calling for special notice was observed, but during the Portbury excursion a large number of larvæ of *Eupithecia campanulata* were taken, this being the only locality for this species round Bristol.

At the in-door meetings of the Section no paper of importance has been read, but a large number of species have been exhibited by various members, including many fine specimens both British and foreign.

GEO. HARDING, *Hon. Sec.*

FLORA OF THE BRISTOL COAL-FIELD.

ADDITIONS TO PARTS I. AND II.

Some discoveries have been made, and much additional information received, since the publication of Part II. The more important facts are given below.

Fumaria pallidiflora, *Jord.* *a.* **Jordani.**

On a hedge-bank between Axbridge and Cheddar. June, 1882. First record for this species.

Cardamine impatiens, L. has now another station in Gloucestershire, having been found on the border of a wood near Tortworth.

Sisymbrium Sophia, L. Berrow, S. June, 1880. *Rev. R. P. Murray.*

Draba muralis, L. We learn that this plant grows in abundance in East Somerset; at Mells, Chelwood, Stone Easton, and Horrington.

Lepidium latifolium, L. Is plentiful on a high bank by the road side at Berrow, S. No doubt an alien here.

Sagina maritima, Don. We thought this was confined to the coast, but *Rev. R. P. Murray* has gathered it on Black Down.

Rubus discolor, *W. & N.* *var.* **leucocarpus.**

In an old hedge at the foot of the Mendips near Axbridge, S. An amber-fruited blackberry. This most interesting plant was discovered by Mr. Read, and has been described by the Editor in Journ. of Bot., Nov., 1882. It may be noted that prior to this discovery a white-fruited bramble had not been noticed in the kingdom during nearly two centuries.

The following aliens (with others) have been found on old colliery *débris* near Kingswood, G. An account of this remarkable colony is given in the Transactions of our Society:—

Delphinium Ajacis.
Farsetia incana ?
Erysimum orientale.
Satureia hortensis.
Dianthus prolifer.
Silene dichotoma.
Trifolium supinum.
Medicago sativa.
Bupleurum rotundifolium.
Glaucium phœnicium.
Camelina sativa.
Gilia capitata.
Gypsophila muralis.
Saponaria Vaccaria.
Silene noctiflora.
Melilotus alba.
Medicago falcata.

We are glad to be able to announce that renewed search has shewn that several plants which it was feared had become extinct upon Brandon Hill are still in existence. Not only *Scleranthus annuus*, but also *Montia fontana*, *Ornithopus perpusillus*, and *Trifolium subterraneum*, have been seen at this spot during the past year.

March, 1883.

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PART VI.

BY ALFRED E. HUDD, M.E.S.

TINEINA.

LEMNATOPHILA PHRYGANELLA. H. Almondsbury, Stapleton; and Leigh Woods. Not common.

,, SALICELLA. H. Common near the Barton Regis Workhouse, Bristol, in April. Mr. Harding met with a few specimens in Pembroke Road, Clifton, some years ago.

EXAPATE GELATELLA. L. Sparingly in hedges round Bristol, Horfield, Stapleton, Redland, &c., in October and November. The late Mr. Wilkinson met with the larvæ near Bristol, between united leaves of willow, in July, 1850. See *Entomologist's Annual* for 1857.

DIURNEA FAGELLA. W.V. Abundant in all stages throughout the district; a black variety has been taken freely by Mr. Vaughan in the Leigh Woods.

EPIGRAPHIA AVELLANELLA. H. Among birch trees at Leigh, Failand, &c., flying at dusk in March and April.

EPIGRAPHIA STEINKELLNERIELLA. S. Used to be taken freely by Mr. Vaughan on blackthorn bushes on Durdham Down, by Mr. Hill at Almondsbury, and by Mr. Harding at Stapleton; I have met with a few on Leigh Down, where it seems to be rather scarce.

TALÆPORIA PSEUDO-BOMBYCELLA. O. The larvæ of this species used to be taken by Mr. Harding on tree trunks near Stapleton; they make long slender cases, and feed on lichens; also recorded by Mr. Vaughan from Brislington, &c.

PSYCHE ROBORICOLELLA B. (=NITIDELLA. S.) The curious cases formed by the larvæ of this species are sometimes common on St. Vincent's Rocks, on Durdham and Clifton Downs, and near Stapleton; they generally produce apterous females, males being comparatively scarce.

SOLENOBIA INCONSPICUELLA. S. These larvæ, in short three-sided cases, have been found freely on old walls, palings, &c., near Bristol, and Redland, by Mr. Vaughan and Mr. Harding; they should be collected during the winter and spring, and are easily reared.

,, POMONÆ. S. Larvæ of this peculiar insect, in cases shorter and rounder than those of *S. inconspicuella*, used to be plentiful on some old pear trees in Mr. Harding's garden at Stapleton, on ground now covered by the Bristol Gas Works. Mr. Harding, Mr. Vaughan, and I bred hundreds of specimens, *all apterous females*, not a single male appearing during several years. Though numerous larvæ were turned out by Mr. Vaughan and others, on old fruit trees at Redland and elsewhere, the species seems to have quite died out in this neighbourhood, and there seems now to be little hope of our discovering the male, or of solving the mystery connected with this curious species. See *Entomologist's Weekly Intelligencer, Vol. VI., p.* 28, and *Entomologist's Monthly Magazine, Vol. VI., pp.* 91—93.

POZCHOIDES VERHUELLELLA. H. The first British specimen of this still local insect was taken at Almondsbury by Mr. Allen Hill. See *Insecta Britannica, Vol. III., p.* 39. Stapleton, Almondsbury; Leigh Woods. The moths fly in the sunshine, and the larvæ burrow under the fructification of *Asplenium,* &c., on old walls.

DIPLODOMA MARGINEPUNCTELLA. S. Two specimens were taken by Mr. Harding at Stapleton, and a few near Almondsbury by Mr. Hill. They fly near hedges, at dusk, in June and July.

XYSMATODOMA MELANELLA. H. Scarce near Bristol, Durdham Down, Stapleton, and Almondsbury. Mr. Harding and I took several larvæ on the trees on which we found the cases of *S. pomonæ,* and bred both sexes. Mr. Harding thought the last-named species might prove to be an apterous form of *melanella,* there being little difference in the cases from which they were reared, but his view has not been generally accepted. See *Entomologist's Monthly Magazine, Vol. VI., pp.* 91—93.

„ ARGENTIMACULELLA. S. Scarce near Bristol, by Mr. Hill, in Woodland Copse, Almondsbury; and by Mr. Sircom, near Brislington, one specimen only, which is in Mr. Vaughan's collection.

Phygas birdella. C. A single specimen was bred recently from a larva found near Horfield by Mr. W. H. Grigg; it used to be taken plentifully by Mr. Sircom on old walls at Brislington, and by Mr. Vaughan at Arno's Vale.

,, bisontella. L. Recorded only by Mr. Hill, from Stoke Park, near Almondsbury, taken between 12 and 2 p.m., in July.

Scardia emortuella. Z. (=corticella. S.) Recorded only by Mr. Duck, from Portishead, whose specimen is now in the collection of the Bristol Museum. The larvæ, according to Stainton, feed in fungi on hornbeams.

,, carpinetella. G. (=parasitella. S.) Scarce near Bristol and Almondsbury; and amongst old bushes and firs in Leigh Woods.

,, granella. L. Abundant in warehouses and houses in Bristol, Horfield, Almondsbury; and near Portishead.

,, cloacella. H. Common in woods at Almondsbury; and in Leigh Woods, Portishead, &c.

,, arcella. F. Durdham Down, Almondsbury, Hortham; Leigh Woods, Portishead, &c.

Tinea ferruginella. H. Scarce on Durdham Down; and in Leigh Woods, by Mr. Sircom and Mr. Vaughan.

,, rusticella. H. Abundant everywhere.

,, tapetzella. L. Abundant throughout the district.

,, ruricolella. S. "Common near Bristol," *Stainton's Manual, Vol. II., p.* 292. Mr. Grigg believes he has taken a few specimens in Leigh Woods.

TINEA ALBIPUNCTELLA. H. Scarce near Brislington, and in Leigh Woods, by Mr. Sircom and Mr. Vaughan.

,, PELLIONELLA. L. Abundant in houses.

,, FUSCIPUNCTELLA. H. Abundant everywhere.

,, PALLESCENTELLA. S. In warehouses in Bristol, not common; recorded only by Mr. Grigg.

,, GANOMELLA. T. (=LAPELLA, S.) Common round Bristol, Clifton, Almondsbury; Brislington, Leigh, Portishead, &c., in woods.

,, BISELLIELLA. H. Abundant everywhere. Mr. Vaughan writes, "a great pest wherever it gets an entrance, feeding on all sorts of dry matter, especially cow-hair." Mr. Grigg showed me a fine series he had bred *from an old pair of slippers.* It is most destructive in museums.

,, NIGRIPUNCTELLA. H. Taken commonly by Mr. Vaughan in outhouses at Redland, and by Mr. Hill at Almondsbury.

,, SEMIFULVELLA. H. Amongst old hedges and buildings near Redland and Almondsbury; also near Brislington and in Leigh Woods.

,, BISTRIGELLA. H. Amongst birch trees in Leigh Woods, not common. I fancy this species is misplaced in the genus *Tinea.*

LAMPRONIA QUADRIPUNCTELLA. F. Common round Bristol, Redland, Almondsbury; Brislington, Leigh, Portishead, &c., amongst wild roses in hedges.

,, LUZELLA. H. Scarce in bushy places near Rudgewood and Almondsbury; also near Brislington and in Leigh Woods.

,, PRÆLATELLA. W.V. Generally distributed throughout the district, but never common. Larvæ on wild strawberry leaves.

LAMPRONIA RUBIELLA. B. Abundant amongst old raspberry canes in gardens at Redland, Clifton, Henbury, Stapleton; Brislington, &c.

INCURVARIA MASCULELLA. W.V. Common everywhere in hedges.

,, OEHLMANNIELLA. H. Common throughout the district, in woods.

,, CAPITELLA. L. Amongst currant bushes in old gardens at Redland, Stapleton, Almondsbury; Brislington, &c.

MICROPTERYX CALTHELLA. Z. Common, but local, near Bristol, Almondsbury; Leigh, Portishead, &c.; often found on flowers of *Viburnum lantana.*

,, SEPPELLA. F. Not common near Bristol, Almondsbury; and in Leigh Woods, &c., flying over *mercurialis*, and at rest on flowers.

,, ARUNCELLA. S. "Abundant near Bristol," *Manual, II., p.* 302. No recent records.

,, ALLIONELLA. F. Common in Frome Glen, near Stapleton, and at Almondsbury.

,, THUNBERGELLA. F. Abundant throughout the district, flying in the sunshine, in May.

,, PURPURELLA. S. Common near Bristol; Leigh Woods, Clevedon, &c.

,, SEMIPURPURELLA. S. In woods near Bristol; Leigh, Portishead, &c. Not common.

,, UNIMACULELLA. Z. Reported by Mr. Grigg from the Leigh Woods, and by Mr. Vaughan from Brislington, amongst birch in April.

,, SUBPURPURELLA. H. Common throughout the district, in oak woods.

NEMOPHORA SWAMMERDAMELLA. L. Common in woods.

,, SCHWARZIELLA. Z. In woods and hedges throughout the district.

ADELA FIBULELLA. W.V. On flowers of *Veronica* in May and June, round Bristol, Almondsbury; Brislington, Portishead, &c. Not common.

,, RUFIMITRELLA. S. Recorded from Almondsbury by Mr. Hill; and from Brislington by Mr. Sircom, whose specimens (three) are in Mr. Vaughan's collection. There are also two in the Duck collection, probably from Portishead.

,, SULZELLA. W.V. Not scarce in woods near Bristol, Almondsbury; Leigh, Portishead, &c.

,, DEGEERELLA. L. Used to be taken freely by Mr. Harding at Stapleton, by Mr. Vaughan at Hanham, and by Mr. Sircom at Brislington. It is now scarce, the only recent captures having been in Portbury Wood.

,, VIRIDELLA. L. Abundant everywhere in oak woods.

,, CUPRELLA. F. Three specimens from Brislington were recorded by Mr. Sircom, in the third volume of the *Zoologist*. There are also specimens in the Duck collection.

NEMOTOIS SCABIOSELLUS. S. Taken by Mr. Hill, "at rest on *Scabious* in Woodland Copse, near Almondsbury, in June." No recent records.

,, CUPRIACELLUS. H. Both sexes taken at rest on teazles, on the Avonmouth railway bank, near Clifton; and at Leigh. In the *Manual, Vol. II., p.* 301, Stainton says, "the male of this species is unknown."

SWAMMERDAMIA COMPTELLA. S. (=APICELLA. St.) In gardens and hedges near Redland, Stapleton, Henbury, Almondsbury; Clevedon, Portishead, &c., amongst plums.

SWAMMERDAMIA SPINIELLA. Z. (=CÆSIELLA. S.) Common amongst sloe bushes.

,, OXYACANTHELLA. M. Common amongst hawthorn.

,, LUTARELLA. H. (=LUTAREA. S.) Hedges and thickets, near Bristol and Almondsbury.

,, PYRELLA. V. Common in gardens and hedges throughout the district.

SCYTHROPIA CRATÆGELLA. L. Very local and not common in the district; larvæ on hawthorn on the Downs, Bristol; and near Brockley Coombe.

YPONOMEUTA PLUMBELLA. W.V. Amongst spindle on Durdham Down, Westbury, Horfield, Almondsbury; Leigh Woods, Portishead, &c.

,, PADELLA. L. Generally distributed in gardens and orchards, but not nearly so destructive here as near London, where I have seen orchards quite defoliated by the larvæ.

,, COGNATELLA. H. (=EVONYMELLUS. S.) Abundant amongst spindle.

,, EVONYMELLA. L. (=PADI. S.) Not common, larvæ on wild cherry.

ANESYCHIA DECEMGUTTELLA. H. Mr. Vaughan informs me he used to take this pretty species on Durdham Down, and on rough ground where Westbury Park now stands. The larvæ feed on *Lithospermum* in September.

PEPILLA CURTISELLA. D. Abundant amongst ash trees throughout the district, varying much in colour, from white to nearly black.

EIDOPHASIA MESSINGIELLA. S. Taken freely by Mr. Vaughan and Mr. Sircom flying before dusk over herbage, in June and July, near Brislington.

PLUTELLA XYLOSTELLA. L. (=CRUCIFERARUM. S.) Abundant everywhere, in gardens, amongst cabbage, &c.

,, PORRECTELLA. L. Abundant in gardens amongst *Hesperis matronalis*, throughout the district.

HYPOLEPIA SEQUELLA. L. Generally distributed but not common. At rest on tree-trunks near Redland, Almondsbury; Leigh, Brislington, Portishead.

,, VITTELLA. L. Generally distributed and common; varies much in colour.

,, RADIATELLA. D. Abundant everywhere. Mr. Vaughan writes, "more variable even than the preceding species, white, black, and all intermediate shades."

,, COSTELLA. F. Common in oak woods.

YPSOLOPHA SYLVELLA. L. Common amongst oaks near Almondsbury; in Leigh Woods and at Portishead.

,, ALPELLA. W.V. "Beaten from oaks on the west side of Woodland Copse," near Almondsbury, by Mr. Hill; and scarce in Portishead Wood.

,, LUCELLA. F. Two specimens beaten from oaks in Leigh Woods, in July, 1882, by Mr. Grigg.

HARPIPTERYX SCABRELLA. L. Durdham Down, Cotham, Redland, Henbury, Almondsbury, Stapleton. Mr. Vaughan writes, "larvæ common on whitethorn, and very active."

,, NEMORELLA. L. Recorded only by Mr. Hill from Knole Park, near Almondsbury.

,, HARPELLA. W.V. (=XYLOSTELLA. S.) Abundant everywhere, amongst honeysuckle.

PTEROXIA CAUDELLA. L. Generally distributed but not common; most plentiful after hybernation, in March and April, amongst spindle.

ORTHOTÆLIA SPARGANIELLA. T. Scarce near Bristol, in marshes near Ashley Hill, &c., amongst *Sparganium*.

PHIBALOCERA QUERCELLA F. Abundant everywhere in gardens, the larvæ being sometimes quite a pest on evergreens.

DEPRESSARIA COSTOSELLA. H. Common amongst furze on Durdham Down, Almondsbury; Brislington, Clevedon, &c.

,, LITURELLA. W.V. Durdham Down, Patchway. Mr. Vaughan writes, "the larvæ are common on knapweed at Keynsham, and easy to rear."

,, PALLORELLA. Z. A single specimen was reared by Mr. Hill from a larva taken on *Angelica*, near Almondsbury, in 1851. According to the *Manual* this was formerly common near Bristol, but is now scarce.

,, UMBELLELLA. S. Common amongst furze throughout the district.

,, ASSIMILELLA. T. Amongst broom near Bristol, Stapleton, Almondsbury, &c. Not common.

,, NANATELLA. S. Common amongst carline thistles on downs near Clifton, Redland; Clevedon, Weston, &c.

,, ATOMELLA. W.V. Recorded by Mr. Hill (in the *Zoologist, Vol. VIII.*) from flowers of golden rod, near Almondsbury; and by Mr. Sircom, from amongst broom, near Keynsham.

,, SCOPARIELLA. Larvæ found on broom *(Spartium scoparia)* near Almondsbury, by Mr. Hill.

,, ARENELLA. W.V. Common everywhere.

,, PROPINQUELLA. T. Near Bristol, Almondsbury, Patchway; Portishead, &c. Not common.

DEPRESSARIA SUBPROPINQUELLA. S. Recorded only by Mr. Hill from "hedges near Patchway."

" ALSTRŒMERIELLA. L. Common everywhere amongst hemlock *(Conium maculatum)*.

" VACCINELLA. H. (= PURPUREA. S.) Not scarce near Bristol, Almondsbury; Brislington, Portishead, &c.; from thatch.

" CAPREOLELLA. Z. "Bristol," Stainton's *Manual*. No recent records.

" HYPERICELLA. H. Common in the larval state on St. John's wort in woods.

" CONTERMINELLA. Z. Common amongst sallows near Bristol, Stapleton, Almondsbury; Brislington, &c.

" ANGELLICELLA. H. Damp woods near Bristol, Almondsbury; Leigh, Portishead. Not common, and difficult to rear.

" OCELELLA. F. Stapleton, Horfield; Brislington, Portishead, &c. Not common.

" YEATSIELLA. F. Not scarce in hedges and outhouses, and from thatch, near Bristol, Almondsbury; Portishead, &c.

" APPLANELLA. F. Common everywhere.

" CILIELLA. S. Mr. Hill records this as "taken at Almondsbury, larvæ on *Angelica* in July, imagines in August." I beat specimens from thatch, near Patchway, in April, 1882.

" PIMPINELLA. Z. Taken by Mr. Sircom, near Brislington, at the end of August.

" ALBIPUNCTELLA. H. Mr. Hill writes, "it flies at dusk along hedges near Almondsbury." I know of no recent captures in the district. In the *Nat. Hist. Tineina, Vol. VI.*, Stainton says, "a local species; it occurs near Bristol."

DEPRESSARIA PULCHERIMELLA. S. Mr. W. H. Grigg and I beat a fine specimen of this local species from thatch near Patchway, in April, 1882.

„ CHÆROPHYLELLA. D. Scarce near Almondsbury, by Mr. Hill. No recent records.

„ ULTIMELLA. S. Scarce near Bristol, and Woodland Copse, near Almondsbury.

„ NERVOSELLA. H. Common and generally distributed. Larvæ on *Œnanthe crocata* and *Cicuta virosa,* in July.

„ BADIELLA. H. A few specimens have been taken near Bristol by Mr. Vaughan and Mr. Grigg.

„ DISCIPUNCTELLA. H. (=PASTINACELLA. S.) "Bristol," Stainton's *Manual, Vol. II., p.* 328. No recent records. This species is represented in the Duck collection, probably from Portishead.

„ HERACLEELLA. D. Not rare near Bristol, Almondsbury, Patchway; Leigh, Portishead, &c. May be beaten from thatch.

PSORICOPTERA GIBBOSELLA. S. Mr. Hill records this as being "scarce in gardens and plantations near Hortham and Almondsbury, on aspen trunks"; and Mr. Vaughan writes, "not rare on trunks in Leigh Woods."

GELECHIA CINERELLA. L. Plentiful on heaths and downs, amongst fern, flying before dusk, in June and July.

„ RUFESCENTELLA. H. Common and generally distributed, flying at sunset in July.

GELECHIA GERRONELLA. Z. Not scarce on Durdham Down; near Brislington and Hanham.

" TEMERELLA. L. Recorded only by Mr. Vaughan from amongst sallows near Brislington.

" POPULELLA. L. Common amongst poplars and sallows.

" LENTIGINOSELLA. Z. Scarce near Bristol, in July and August; larvæ in shoots of *Genista* in May and June. "It was first detected in England, near Bristol," *N. H. Tineina, IX.*

" ERICETELLA. H. Common on heaths and downs.

" MULINELLA. T. Plentiful amongst broom, in July and August, near Stapleton, Almondsbury; Brislington, Keynsham, &c.

" SORORCULELLA. H. Scarce amongst sallows in July, in Hortham Wood, near Almondsbury; near Brislington, &c.

" DIFFINELLA. H. In grassy places in May and June, Bristol, Stapleton, Almondsbury; Portishead.

" TERRELLA. W.V. Common everywhere.

" DESERTELLA. E. A few specimens have been taken recently on Durdham Down, by Mr. Grigg.

" ACUMINATELLA. S. First discovered by Mr. Sircom, and described by him in the *Zoologist* for 1850, from specimens captured at Brislington. The larvæ are found in the autumn, on thistles, near Bristol, Redland, Almondsbury; Leigh Down, Brislington, &c.

" ARTEMISIELLA. T. Common amongst wild thyme, in July, on Durdham Down, and near Almondsbury.

" SENECTELLA. Z. Sparingly amongst gorse near Almondsbury; and on Leigh Down.

GELECHIA SIMILELLA. D. Two specimens captured near Bristol by Mr. Grigg have been thus named for him by Mr. C. G. Barrett.

,, AFFINELLA. H. Common on old walls, near Bristol, Redland, Horfield, Almondsbury; Portishead, &c. The larvæ feed on moss during the spring.

,, BASALTINELLA. Z. Recorded only by Mr. Hill from a hedge near Woodland Copse, Almondsbury, in July.

,, DOMESTICELLA. H. Abundant everywhere on old moss-covered walls, in July and August.

,, RHOMBELLA. H. Used to be taken near Stapleton, on Durdham Down; and at Portishead, but has not been met with lately.

,, PROXIMELLA. H. On trunks of trees, &c., near Bristol, Knowle, Almondsbury; Leigh Woods, Portishead, &c. Flies at dusk, amongst birch.

,, NOTATELLA. H. Not scarce amongst sallows near Bristol, Stapleton; and in Leigh Woods.

,, VULGELLA. H. Common amongst hawthorn.

,, LUCULELLA. H. Recorded by Mr. Sircom from Durdham Down; and by Mr. Grigg from Leigh Woods. Amongst oak, scarce.

,, SCRIPTELLA. H. Sparingly amongst maples near Redland; and in Leigh Woods, by Mr. Vaughan.

,, FUGITIVELLA. Z. Mr. Vaughan writes, "in great abundance on elm trees on Durdham Down, varying much in colour."

,, DISTINCTELLA. Z. Recorded by Mr. Sircom from near Keynsham, in July, 1851.

,, COSTELLA. S. Scarce amongst *Solanum* in lanes near Henbury, by Mr. Vaughan, and near Stapleton, by Mr. Harding.

GELECHIA MACULELLA. H. Amongst *Stellaria* in sheltered places near Bristol, Almondsbury; Leigh, Portishead, &c. Not common.

" TRICOLORELLA. H. Stoke Bishop, Almondsbury, &c. Larvæ common in terminal shoots of *Stellaria* in the spring.

" MACULIFERELLA. M. Scarce amongst *Cerastium* by roadsides near Bristol, in July.

" MARMORELLA. H. Recorded by Mr. Duck, from Portishead, scarce. No recent records.

" OBSOLETELLA. F. Larvæ plentiful on *Atriplex* on the Portishead railway-bank, near Leigh Woods, and at Portishead.

" ATRIPLICELLA. F. Amongst *Atriplex* not common, near Redland, Aust; Leigh, &c.

" SEQUACELLA. H. Abundant amongst *Helianthemum* on Durdham Down; and at Leigh.

" LEUCATELLA. L. Common amongst hawthorn.

" ALBICAPITELLA. Z. Amongst willows near Bristol, Horfield, Stapleton; Leigh Woods, Portishead, &c.

" NANELLA. H. Mr. Vaughan writes, "not scarce in my garden at Redland, amongst fruit trees."

" MOUFFETELLA. W.V. Amongst honeysuckle near Bristol, Stapleton; Brislington, Leigh Woods, &c. Not common.

" DODECELLA. L. Amongst Scotch firs in Woodland Copse, near Almondsbury, by Mr. Hill.

" TENEBROSELLA. Z. Scarce, near Bristol, in June and July. No recent records.

" TENEBRELLA. H. Downs and meadows near Almondsbury, Patchway; Leigh, &c.

" LIGULELLA. Z. Durdham Down, Patchway and Almondsbury, in June and July, scarce.

GELECHIA TÆNIOLELLA. T. Plentiful amongst *leguminosæ* on downs throughout the district.

" SIRCOMELLA. S. Scarce on Durdham Down, where it was first taken by Mr. Sircom. Mr. Vaughan thinks this may be only a variety of the last, with which it is generally found.

" ANTHYLLIDELLA. H. Plentiful amongst *Anthyllis* throughout the district.

" ATRELLA. H. Common near Bristol, Almondsbury; Brislington, Leigh, Clevedon, &c.

" BIFRACTELLA. M. Common amongst fleabane throughout the district; larvæ on seed-heads of that plant during the winter.

" LUCIDELLA. S. In marshy places near Portishead in July. Recorded only by Mr. Duck.

" LUTULENTELLA. Z. Recorded only by Mr. Hill, from "the borders of a brook near Almondsbury, much crowded with *Hippuris vulgaris*; they fly at sunset, in June and July."

" GEMMELLA. L. Scarce in Leigh Woods, in July and August.

" NÆVIFERELLA. Z. Rudgewood and Almondsbury, by Mr. Hill; and Portishead, by Mr. Vaughan.

" INOPELLA. Z. Not scarce amongst fleabane at Leigh.

" SUBOCELLELLA. S. Larvæ in curious brown cases on seedheads of marjoram, sometimes plentiful under St. Vincent's Rocks, and near Almondsbury, in September and October.

PARASIA LAPPELLA. L. Mr. Harding used to take the larvæ in seeds of burdock, near Stapleton, during the winter.

" CARLINELLA. D. Common amongst carline thistles, especially in the larval state.

CLEODORA CYTISELLA. C. Mr. Vaughan writes, "very local, but abundant in spots on Clifton Down; and at Leigh, in July."

CHELARIA CONSCRIPTELLA. H. (=HUBNERELLA. St.) Common in September near Durdham Down, Almondsbury; Leigh, Portishead, &c.

ANARSIA SPARTIELLA. S. Taken by Mr. Hill amongst broom in Stoke Park. near Almondsbury, in July.

NOTHRIS DURDHAMELLA. S. Not scarce amongst marjoram on Durdham and Clifton Downs, Stoke Bishop; Leigh, Portishead, &c. The pretty larvæ are sometimes common in June, on marjoram.

HARPELLA GEOFFRELLA. L. Not scarce in woods and hedges near Bristol, Stoke Bishop, Almondsbury; Leigh, Portishead, &c. Mr. Harding tells me he bred some specimens from stems of some dry umbelliferous plants, but he does not remember what the larvæ were like; they are still undescribed. I generally find this beautiful insect amongst privet hedges, but have searched in vain on that plant for the larvæ.

DASYCERA SULPHURELLA. F. Common in old woods and hedges throughout the district; larvæ in decaying wood.

ŒCOPHORA MINUTELLA. L. Common in gardens and outhouses at Redland, Almondsbury; Brislington, Portishead, &c., in May and June.

„ FLAVIMACULELLA. S. Scarce in damp woods near Stapleton, Almondsbury; Brislington, Leigh, &c., in August.

„ TRISIGNELLA. Z. (=TRIPUNCTA. S.) Scarce, on Durdham Down, by Mr. Vaughan, and near Almondsbury, by Mr. Hill.

Œcophora augustella. H. Scarce on tree trunks on Durdham Down; and near Brislington.

,, formosella. W.V. Scarce in Woodland Copse, Almondsbury. Recorded only by Mr. Hill.

,, lunarella. H. Taken sparingly by Mr. Vaughan on trunks of trees, near Brislington, in August.

,, lambdella. D. Scarce amongst broom in June and July, near Bristol, Stapleton, Hanham; Brislington, Keynsham, &c.

,, tinctella. T. A few specimens in the Gully, Durdham Down, by Mr. W. H. Grigg.

,, subochreella. D. (=panzerella. S.) Not scarce on Durdham Down in June and July.

,, fuscoaurella. H. (=unitella. S.) Scarce amongst old trees and hedges on Durdham Down, Stapleton, Almondsbury, &c.

,, flavifrontella. H. Scarce at light at Redland, and on Durdham Down.

,, fuscescentella. H. Not rare in gardens and outhouses at Redland; and near Portishead.

,, pseudospretella. S. Abundant everywhere, the larvæ being amongst the most troublesome of our domestic pests, feeding on all kinds of dry substances. Mr. Vaughan bred a series *from a wax candle.*

Œgoconia kindermanniella. Z. (=quadripuncta S.) Rather common at Redland and near Almondsbury; comes freely to light.

Endrosis fenestrella. S. Abundant everywhere in houses.

Butalis grandipennella. H. Plentiful on downs near Bristol, Thornbury; Leigh, &c. Larvæ in white webs on furze bushes.

Butalis fuscoæneella. H. Taken by Mr. Sircom near Brislington; his specimens are now in Mr. Vaughan's collection.

,, fuscocuprella. H. Mr. Vaughan states, "this used to be common amongst *Cistus* on Durdham Down; near Brislington, and in Leigh Woods, and is, I think, double-brooded."

,, senescentella. S. Mr. Grigg records this from Durdham Down, in July. It is probably not distinct from the last named.

,, variella. S. Taken by Mr. Hill near Almondsbury, not scarce; there are some specimens in the Duck collection, which were probably from Portishead.

Pancalia lewenhoekella. L. On the slopes of Durdham Down, Henbury, Almondsbury; Leigh Woods, Portishead, &c. This beautiful species used to be plentiful, but is now scarce.

Acrolepia perlepidella. S. Leigh Woods and the bank of the Avon. Mr. Grigg succeeded in discovering the larvæ of this local insect, mining leaves of *Inula conyza* in Leigh Woods, in the spring. For description of the larvæ, &c., see *Entomologists' Monthly Magazine, Vol. XVI., pp.* 34—36. Mr. H. T. Stainton says (*ib., p.* 36) "The discovery is of extreme interest, as no one had previously even suspected the correct food plant."

,, granitella. T. Amongst fleabane in woods near Bristol, Almondsbury; Leigh, Portishead, &c.

,, autumnitella. C. (= pygmæana. S.) Taken by Mr. Hill, flying before sunset in September, in woods near Almondsbury, scarce.

ROSLERSTAMMIA ERXLEBELLA. F. Scarce amongst *Tilia parvifolia* in Frome Glen, near Stapleton; more plentiful in Leigh Woods. The larva of this species also has been discovered by Mr. Grigg, and was described by Mr. Stainton in the *E. M. M., Vol. XVI., p.* 94.

GLYPHIPTERYX FUSCOVIRIDELLA. H. Plentiful in May and June, flying over grass and flowers, in the sunshine, in meadows near Stapleton, Almondsbury; Brislington, Pensford, Portishead, &c.

" THRASONELLA. S. Not scarce near Almondsbury and on the banks of the Avon near Sea Mills; Portishead, &c., amongst rushes.

" EQUITELLA. S. Common amongst *Sedum* on old walls and gardens near Bristol, Redland, Stapleton, Almondsbury, &c.

" FISCHERIELLA. Z. Common in grassy places throughout the district.

PERITTIA OBSCUREPUNCTELLA. S. Not common near Bristol. Mr. Hill used to take it at Almondsbury; and Mr. Sircom "frequenting hedges near Brislington, early in the spring."

TINAGMA SERICIELLA. H. Amongst broom and bushes near Stapleton, Almondsbury; Keynsham, &c.

" STANNEELLA. F. Beaten from yews in Leigh Woods by Mr. Grigg, and scarce in woods near Brislington by Mr. Sircom.

" RESPLENDELLA. D. Mr. Vaughan has some specimens in his collection which were taken by Mr. Sircom at Brislington.

ARGYRESTHIA EPHIPPELLA. F. Leigh Woods, by Mr. Vaughan, and Portishead by Mr. Duck.

ARGYRESTHIA NITIDELLA. F. Common amongst hawthorn throughout the district.

" SEMITESTACELLA. C. Scarce amongst beeches near Bristol, Over Park, and Almondsbury.

" SPINIELLA. Z. Taken by Mr. Sircom near Brislington.

" ALBISTRIELLA. H. Common amongst sloe bushes.

" SEMIFUSCELLA. H. Scarce in gardens and hedges, in August. Cook's Folly Woods, Bristol, Almondsbury; Portishead, &c.

" MENDICELLA. H. Common on Durdham Down in June, amongst sloe.

" GLAUCINELLA. Z. Not scarce on oak trunks in Leigh Woods, Brislington, and Portishead.

" RETINELLA. Z. Common in birch woods and plantations near Almondsbury; on Leigh Down and near Portishead.

" DILECTELLA. Z. "The first English specimens were taken near Bristol by Mr. Dale." *Zoologist, VII.* It used to be taken amongst juniper bushes on lawns at Almondsbury; and near Brislington.

" CURVELLA. L. Common in orchards at Almondsbury; and Portishead.

" SORBIELLA. T. Scarce in Leigh Woods, by Mr. Vaughan. The larvæ are found in leaf buds of *Pyrus aria*, &c., in May.

" PYGMÆELLA. H. Common amongst sallows near Stapleton, Hanham, Almondsbury; Brislington, Portishead, &c.

" GOEDARTELLA. L. Mr. Vaughan says, "plentiful in all states on birches on Leigh Down; less so on Durdham Down. Very variable."

ARGYRESTHIA BROCKEELLA. H. Common amongst birch trees.

,, ARCEUTHINELLA. Z. Amongst junipers in gardens at Brislington, by Mr. Sircom.

CEDESTIS FARINATELLA. D. A single specimen of this northern species was beaten by Mr. Grigg from a larch tree in Leigh Woods, in June, 1883.

OCNEROSTOMA PINIARIELLA. Z. Amongst pines near Almondsbury, by Mr. Hill; and in Leigh Woods, by Mr. Grigg.

ZELLERIA HEPARIELLA. M. Recorded by Mr. Hill from plantations near Almondsbury; on the wing from August to October.

,, INSIGNIPENNELLA. S. A fine specimen captured in the Leigh Woods by Mr. Grigg, was named for him by Mr. C. G. Barrett.

GRACILARIA ALCHIMIELLA. S. (=SWEDERELLA. St.) Common everywhere in oak woods.

,, STIGMATELLA. F. Amongst sallows near Almondsbury; and in Leigh Woods.

,, SEMIFASCIELLA. H. Scarce, in October, at ivy bloom and in woods, near Bristol, Almondsbury; Portishead, &c.

,, ELONGELLA. L. Scarce near Bristol amongst alders, by Mr. Grigg.

,, TRINGIPENNELLA. Z. Common amongst plantains on slopes of Downs near Bristol, and on railway banks; larvæ sometimes abundant.

,, SYRINGELLA. F. Too plentiful in gardens and plantations amongst lilac and privet.

,, AUROGUTTELLA. S. Not rare in woods near Bristol, Almondsbury; Leigh, Keynsham, Portishead, &c., amongst St. John's wort.

CORISCIUM BRONGNIARDELLA. F. This species used to be common amongst oaks near Almondsbury; and at Brislington, Keynsham, &c. It seems to have become scarce in the district of late.

,, CUCULIPENNELLA. H. Scarce amongst privet on Durdham Down, Stoke Bishop, Almondsbury; Portishead, &c.

,, CITRINELLA. F. (=SULPHURELLUM. S.) Recorded by Mr. Hill from "trunks of trees near Almondsbury, scarce."

ORNIX AVELLANELLA. S. Common amongst nut bushes on Durdham Down, Stapleton, Westbury; Leigh.

,, ANGLICELLA. S. Common in Frome Glen, near Stapleton, Almondsbury; and in Leigh Woods.

,, BETULÆVORELLA. D. Not scarce amongst young birch trees in Leigh Woods; double-brooded.

,, FAGIVORELLA. F. Larvæ found in beech leaves near Bristol, have been bred by Mr. Vaughan.

,, SCOTICELLA. S. "More peculiarly a northern insect, though it occurs at Bristol." *Nat. Hist. Tineina, Vol. VIII*, p. 258. No recent captures in this locality, I think.

,, GUTTELLA. H. Sparingly in orchards at Hortham and Almondsbury; and near Brislington.

COLEOPHORA FABRICIELLA. V. Fields near Bristol, and Stapleton, by Mr. Grigg; Almondsbury, Patchway, &c., by Mr. Hill; and banks of the Avon, near Keynsham, by Mr. Vaughan.

,, DEAURATELLA. L. Recorded only by Mr. Hill. "Flies at dusk over clover and long grass near Patchway and Almondsbury; local."

COLEOPHORA ALCYONIPENNELLA. K. Almondsbury and Patchway, by Mr. Hill, and Brislington by Mr. Sircom, amongst *Centaurea nigra.*

" WOCKEELLA. Z. A specimen taken by Mr. Grigg in the Gully, Durdham Down, was named for him by Mr. C. G. Barrett.

" OCHREELLA. H. Common amongst *Helianthemum* on the slopes of Durdham Down; and less plentiful on Leigh Down. The larvæ, in their curious long cases, are generally to be found on plants growing in the most rocky and exposed situations.

" LIXELLA. Z. Plentiful on the exposed grassy slopes of Clifton and Durdham Downs; and not rare on Leigh Down.

" CONYZÆ. Mr. W. H. Grigg bred a specimen of this local species from a larva found by him in Leigh Woods feeding on *Inula conyzæ.*

" PYRRHULIPENNELLA. T. On heaths near Bristol, Redland, Wotton-under-Edge; Leigh Woods.

" ALBICOSTELLA. H. Abundant amongst furze.

" ANATIPENNELLA. H. Common, especially in the larval state on fruit trees, &c., Redland, Henbury, Stapleton, Almondsbury; Brislington, Bath, &c.

" PALLIATELLA. Z. Taken by Mr. Hill amongst sallows near Almondsbury, in June and July.

" IBIPENNELLA. H. A few by Mr. Vaughan amongst birch trees in Leigh Woods.

" CURRUCIPENNELLA. F. Recorded by Mr. Hill from near Almondsbury, amongst sallows.

" NIVEICOSTELLA. F. Taken by Mr. Vaughan on Durdham Down, at the beginning of July.

COLEOPHORA DISCORDELLA. Z. Not scarce amongst *Lotus corniculatus* on Downs near Bristol, Stoke Park, Almondsbury, &c.

,, SATURATELLA. S. A few specimens were captured by Mr. Hill, flying at sunset in July, in Stoke Park, near Almondsbury.

,, THERINELLA. S. Scarce in June and July near Almondsbury; and Leigh. Mr. Grigg reared some from larvæ found on thistles.

,, TROGLODYTELLA. S. Abundant among fleabane on the Avon banks, under Cook's Folly, Hanham; Brislington, Leigh, Portishead.

,, LINEOLELLA. H. Common at Stoke and Almondsbury by Mr. Hill; and in lanes near Bedminster by Mr. Vaughan.

,, MURIPENNELLA. F. Three specimens taken in Leigh Woods by Mr. Grigg have been referred to this species by Mr. H. T. Stainton.

,, CAESPITITIELLA. Z. Abundant amongst rushes on Durdham Down, Stapleton, Stoke, Almondsbury; Leigh, Clevedon, &c. Larvæ on rush seeds during the winter.

,, ANNULATELLA. T. Abundant on the banks of the Avon, Patchway, and Almondsbury.

,, CACUMINATELLA. D. (=APICELLA. S.) Mr. Grigg has taken a single specimen near Bristol, probably at Baptist Mills.

,, ARGENTULELLA. Z. Common on Durdham Down, by Mr. Vaughan, and near Stapleton by Mr. W. H. Grigg, amongst yarrow.

,, VIRGAUREELLA. S. Common in Leigh Woods: larvæ plentiful on golden-rod in the autumn.

Coleophora juncicolella. S. Sparingly on Durdham Down; and at Leigh. Larvæ common on heath during the winter and spring.

,, laricella. H. Bred by Mr. Grigg from larvæ taken on larch trees near Stapleton; and in the Leigh Woods. Not common.

,, albitarsella. Z. Common near Bristol amongst ground-ivy; and in Leigh Woods.

,, nigricella. S. Abundant near Bristol, Clifton, Stapleton, Almondsbury; Brislington, Leigh, Portishead, &c. Larvæ on hawthorn, in May.

,, fuscocuprella. Z. Bristol is the only locality given in Stainton's *Manual, Vol. II., p.* 386, for this species; the larvæ are said to feed in a nearly globular case on the leaves of nut, in July and August, the moths appearing in May and June. I have taken cases on nut, but have not succeeded in rearing the moths.

,, gryphipennella. B. Larvæ common on leaves of wild roses on Durdham Down, Henbury, &c.; and in Leigh Woods.

,, fuscedinella. S. Larvæ common on elms and alders near Bristol, and throughout the district.

,, viminetella. Z. Not scarce by the banks of the Avon; and near Keynsham, amongst sallows.

,, olivacella. S. One specimen bred from a larva taken near Bristol by Mr. Grigg, was named for him by Mr. Stainton.

,, solitariella. Z. A few specimens were bred by Mr. Harding from larvæ taken on *Stellaria holostea* near Stapleton.

COLEOPHORA LUTIPENNELLA. Z. Larvæ sometimes common on birch trees on Durdham Down; and in Leigh Woods.

,, BADIPENNELLA. F. Amongst ash and elm trees in Stoke Park and Almondsbury, by Mr. Hill.

,, LIMOSIPENNELLA. F. Bred plentifully by Mr. Grigg from larvæ taken on Wych elms in the Leigh Woods.

BATRACHEDRA PRÆANGUSTELLA. H. Common amongst willows and poplars near Bristol, Stapleton, Almondsbury; Portishead, &c.

OINOPHILA V. FLAVELLA. H. Too common in some cellars in Bristol, Redland, Clifton, &c.

CHAULIODUS CHÆROPHYLLELLA. G. Near Almondsbury, by Mr. Hill, scarce and local, in October.

LAVERNA PALUDICOLELLA. D. (=PROPINQUELLA. St.) Leigh Woods, &c. Larvæ on *epilobium* in March.

,, LACTEELLA. S. A few specimens amongst *epilobium* in June, taken by Mr. Grigg, at Leigh.

,, MISCELLA. W. V. Abundant amongst *Helianthemum* on slopes of Durdham Down; less common at Leigh and Brislington.

,, EPILOBIELLA. S. Amongst willow-herb in August and September, flying at dusk. Common at Henbury, Almondsbury; on the Portishead Railway bank, and near Keynsham. Larvæ abundant and easy to rear.

,, DECORELLA. S. Scarce amongst willow herb near Keynsham; larvæ in July and August in Leigh Woods.

,, ATRA. H. Larvæ plentiful in the berries of hawthorn in the autumn, in hedges near Bristol, Stapleton, Almondsbury, &c.

LAVERNA, var. NIGRA. S. Less common than the type.

„ VINOLENTELLA. H.S. Two specimens were taken in Leigh Woods by Mr. W. H. Grigg.

CHRYSOCLISTA LINNEELLA. S. Mr. Vaughan writes—"This used to occur in great plenty on trunks of lime trees in College Green and St. Michael's Churchyard, Bristol, and sparingly on Durdham Down." It is now scarce.

„ FLAVICAPITELLA. H. Common in hedges and woods, flying by day.

ASYCHNA MODESTELLA. D. Scarce on Durdham Down and at Almondsbury, in May, amongst *Stellaria*.

„ FUSCOCILIELLA. S. Scarce on slopes of Durdham Down, by Mr. Vaughan.

„ TERMINELLA. D. Near Bristol and Almondsbury; and larvæ common in leaves of *Circæa lutetiana* in Leigh Woods, in the autumn.

CHRYSOCORYS FESTALIELLA. H. Not scarce in woods near Bristol, Almondsbury; Leigh, &c., in May.

ANTISPILA PFEIFFERELLA. F. Amongst dogwood on downs near Bristol, Almondsbury; and Leigh.

„ TREITSCHKIELLA. F. Common amongst dogwood in the same localities as the preceding species.

STEPHENSIA BRUNNICHELLA. L. Rather scarce on Leigh Down, in May, and local.

ELACHISTA GLEICHENELLA. F. Common on dry banks amongst wild carrot, on Durdham Down, near Almondsbury; and Leigh Woods.

„ MAGNIFICELLA. T. Larvæ common near Bristol, Stapleton, Hanham; Brislington, Leigh, &c., in leaves of *Lazula pilosa* in April and May. Mr. Vaughan thinks it is double brooded, as he used to take it at the end of May and again in August. I have not met with the August brood.

ELACHISTA ALBIFRONTELLA. H. Plentiful on downs near Bristol, Almondsbury, Portishead, &c.

" ATRICOMELLA. S. Scarce on the Downs, Bristol, near Rudgewood, and Almondsbury.

" LUTICOMELLA. Z. Amongst *Dactylis* on Durdham Down, near Hortham and Almondsbury.

" CINEREOPUNCTELLA. H. Common throughout the district, in grassy places.

" TRAPEZIELLA. S. Mr. Vaughan says "Common on Durdham Down; Leigh Woods, &c."

" STABILELLA. S. Mr. Grigg takes this plentifully on the Portishead railway bank, where he also finds the larvæ in leaves of *Carex*.

" NIGRELLA. H. Common on Durdham Down, Rudgewood, Almondsbury; bred freely, from larvæ taken at Stapleton, by Mr. Grigg.

" SUBNIGRELLA. D. Taken by Mr. Vaughan plentifully on Durdham Down.

" HUMILIELLA. Z. Recorded only by Mr. Hill: scarce and local in Hortham Wood, near Almondsbury, in May.

" BEDELLELLA. S. First described by Mr. Sircom, in the *Zoologist, Vol. VI.*, from specimens taken on Durdham Down, where it is still plentiful; it is also found less commonly at Leigh and Keynsham.

" SUBOBSCURELLA. D. Abundant in grassy places on Durdham Down, Rudgewood, Almondsbury, &c.; and on Leigh Down.

" ZONARIELLA. T. Mr. Stainton says, *Nat. Hist. Tineina, III.*, *p.* 164, "In the S. of England this has only been met with by Mr. Sircom, near Bristol." Mr. Vaughan tells me he used to take it sparingly amongst herbage near the banks of the Avon at Keynsham.

ELACHISTA GANGABELLA. F. Scarce near Almondsbury, Rudgewood; and on the banks of the Avon under Leigh Woods, in May and June.

,, TAENIATELLA. S. One bred from a larva found at Stapleton by Mr. W. H. Grigg.

,, MEGERLELLA. Z. Common in woods and hedges near Almondsbury; Leigh, Portishead, &c.

,, ADSCITELLA. S. Grassy places near Stapleton, Almondsbury; Brislington, and on the Portishead railway bank.

,, CERUSSELLA. H. Scarce on the banks of the Avon near Bristol, amongst *Arundo phragmites.*

,, RHYNCOSPORELLA. S. Taken by Mr. Vaughan on Durdham Down.

,, BIATOMELLA. S. Not scarce on Durdham and Leigh Downs, in May and August.

,, TRIATOMELLA. H. Durdham Down, not common.

,, TRISERIATELLA. S. Taken freely on the slopes of Durdham Down, by Mr. Vaughan, by whom this species was discovered.

,, DISPUNCTELLA. D. Common on Durdham Down.

,, COLLITELLA. F. (=SUBOCELLEA. S.) Common on Durdham Down and near Almondsbury; less so at Leigh and near Failand.

,, POLLINARIELLA. Z. Not scarce on Durdham Down.

,, RUFOCINERELLA. H. Abundant everywhere.

,, SUBOCHREELLA. D. Scarce, on Durdham Down, by Mr. Vaughan.

,, CYGNIPENNELLA. H. Abundant everywhere.

TISCHERIA COMPLANELLA. H. Plentiful in oak woods.

,, EMYELLA. D. (=MARGINEA. S.) Common amongst brambles, in May and August.

LITHOCOLLETIS ROBORELLA. Z. Sparingly amongst oak trees.

,, HORTELLA. F. Scarce near Brislington, amongst oaks, by Mr. Sircom.

,, AMYOTELLA. D. Scarce at Brislington, by Mr. Sircom and Mr. Vaughan. Figured by Mr. Sircom in *The Zoologist, VI.*

,, LANTANELLA. S. Abundant throughout the district amongst guelder rose.

,, LAUTELLA. Z. Larvæ sometimes abundant in leaves of oaks near Bristol; Brislington, Leigh Woods, &c.

,, POMIFOLIELLA. Z. Abundant throughout the district amongst apple and hawthorn.

,, CORYLELLA. N. Abundant amongst nut bushes.

,, SPINICOLELLA. Z. Scarce amongst sallows near Durdham Down, Hortham, Almondsbury; Brislington, Leigh Woods, &c.

,, FAGINELLA. M. Larvæ plentiful in beech leaves throughout the district.

,, TORMINELLA. F. Scarce amongst *Sorbus torminalis* in Leigh Woods.

,, SALICICOLELLA. S. Common amongst sallows near Almondsbury; Leigh Woods, Brislington, &c. First described and figured by Mr. Sircom in *The Zoologist, VI.*, from specimens taken in the last-named locality.

,, CARPINICOLELLA. S. Amongst hornbeam near Bristol and Almondsbury.

,, ULMIFOLIELLA. H. Common amongst birch.

Lithocolletis spinolella. D. Common in all stages amongst sallows throughout the district.

" quercifoliella. F. Plentiful amongst oaks.

" messaniella. Z. Mr. Vaughan writes "Too common everywhere, nearly every leaf on some trees being tenanted by several larvæ; they swarm on beech trees in my garden."

" corylifoliella. H. Plentiful amongst nut.

" viminiella. S. Another of Mr. Sircom's species, described and figured by him in *The Zoologist, VI.*, from Brislington specimens. Mr. Vaughan says he has never found this species on sallows, but has taken the larvæ in great profusion on osiers at Hanham and Keynsham.

" scopariella. T. Scarce amongst broom near Keynsham, in June and July.

" ulicolella. V. First discovered by Mr. Vaughan amongst furze bushes on Durdham Down, at the end of June, 1850, where it is still to be found, as also on Downs at Leigh, Clevedon, &c.

" alnifoliella. H. Larvæ not scarce in leaves of alder, Clifton, Stapleton; Brislington, &c.

" cramerella. F. Amongst oaks near Bristol, Almondsbury; Leigh Woods, &c.

" heegeriella. Z. Common amongst oaks near Bristol; Leigh, Brislington, &c.

" tenella. Z. Larvæ in the under side of hornbeam leaves near Bristol, in July and September. No recent records.

" acerifoliella. Z. (=sylvella. S.) Abundant on maples near Bristol, Almondsbury, and throughout the district.

Lithocolletis emberizæpennella. B. Scarce amongst honeysuckle near Bristol; Leigh Woods, Brislington, &c.

„ frolichiella. Z. Scarce amongst alders near Bristol and Almondsbury.

„ nicelliella. Z. Common amongst hazel.

„ stettiniella. N. Larvæ in the upper side of alder leaves, near Bristol. No recent records.

„ schreberella. F. Larvæ abundant on elms.

„ tristrigella. H. Abundant amongst elms.

„ trifasciella. H. Common near Bristol, Almondsbury, Henbury; Brislington, Leigh.

Lyonetia clerckella. L. Common and generally distributed. Larvæ plentiful in apple leaves in gardens, and in birch leaves in Leigh Woods.

Phyllocnistis suffusella. Z. Sparingly near Bristol, amongst poplars, by Mr. Vaughan.

Cemiostoma spartifoliella. H. Common amongst broom near Stapleton, Almondsbury; and Brislington.

„ laburnella. H. Abundant amongst *Laburnum* in gardens and plantations.

„ scitella. Z. Plentiful in hedges everywhere.

Opostega crepusculella. F. Taken by Mr. Hill at Stoke Park, near Almondsbury, and at Winterbourne; also by Mr. Sircom at Tockington, and near Brislington. Not common.

Bucculatrix aurimaculella. S. Common amongst ox-eye daisies, on railway banks and waste places throughout the district.

„ ulmella. M. Taken plentifully by Mr. Vaughan in Leigh Woods and near Brislington.

„ vetustella. M. A few from oaks in Woodland Copse, near Almondsbury, by Mr. Hill; no recent records.

BUCCULATRIX CRATÆGIFOLIELLA. D. (=CRATÆGI. S.) Plentiful amongst hawthorn near Bristol, Almondsbury; Brislington, &c.

,, MARITIMELLA. S. Larvæ abundant in leaves of sea-aster on the banks of the Avon near Sea Mills, and found occasionally nearer Bristol, not far from Bedminster Bridge.

,, BOYERELLA. D. Sparingly amongst elms near Patchway; and Brislington.

,, FRANGULELLA. G. Recorded by Mr. Hill from Stoke Park and Almondsbury, not common.

,, HIPPOCASTANELLA. D. Larvæ very abundant in leaves of lime *(Tilia parvifolia)* in Leigh Woods, and near Brislington.

,, CRISTATELLA. F. Larvæ sometimes abundant on yarrow near Bristol, Redland, Stapleton; Keynsham, &c.

NEPTICULA ATRICAPITELLA. H. Common in oak woods.

,, ANOMALELLA. G. Larvæ plentiful in leaves of roses, in October, throughout the district.

,, PYGMÆELLA. S. Common amongst hawthorn.

,, POMELLA. V. First described in the *Intelligencer, Vol. V.*, from specimens taken at Redland by Mr. Vaughan. Larvæ abundant in apple leaves, many mining in a leaf.

,, OXYACANTHÆCOLELLA. D. Abundant amongst hawthorns, throughout the district.

,, VISCERELLA. D. Scarce, bred from larvæ found in elm leaves near Bristol by Mr. Vaughan.

,, CATHARTICELLA. S. Scarce amongst buckthorn in hedges near Bristol, Horfield; Bedminster, &c.

,, SEPTEMBRELLA. S. Abundant amongst *Hypericum* in Leigh Woods, and near Keynsham.

NEPTICULA INTIMELLA. Z. Scarce amongst sallows near Almondsbury; Brislington, Keynsham, &c.; the moths rest on the higher branches of the sallows, in June.

,, SUBBIMACULELLA. H. Abundant in oak woods near Bristol, Almondsbury, Henbury; Leigh, &c.

,, ARGYROPEZELLA. Z. Mr. Vaughan writes—"Larvæ plentiful in Leigh Woods in fallen aspen leaves in October, but not so easy to rear as most *Nepticulæ;* only one larva mines in each leaf, close to the foot-stalk." See *Intelligencer, Vol. VI.*

,, TRIMACULELLA. H. Mr. Vaughan writes—"Common on Lombardy poplar trunks in my garden at Redland; the larvæ mine the leaves in June and September."

,, SERRICOPEZELLA. Z. (=LOUISELLA. *Sircom.*) There are three specimens in Mr. Vaughan's collection all taken at Brislington, two by himself, the other by Mr. Sircom.

,, FLOSLACTELLA. H. Plentiful amongst nut bushes.

,, SALICIVORELLA. D. (=SALICIS S.) Abundant amongst sallows near Bristol, Stapleton; Leigh Woods, Brislington, &c.

,, MICROTHERIELLA. W. Abundant everywhere amongst nut bushes. This is said to be the smallest known Lepidopterous insect; the larvæ are very gregarious, as many as thirty having been found in a single nut leaf.

,, IGNOBILELLA. S. Amongst hawthorn in hedges near Bristol, not very common.

,, ARGENTIPEDELLA. Z. Common round Bristol amongst birch, especially in the Leigh Woods.

NEPTICULA TITYRELLA. D. Common amongst beech trees.

" MALELLA. S. Scarce near Bristol in leaves of wild apple. No recent records.

" ANGULIFASCIELLA. S. Used to be plentiful amongst roses, but seems to have become scarce of late.

" GRATIOSELLA. S. Scarce amongst hawthorn on Durdham Down, in May, by Mr. Vaughan.

" MARGINECOLELLA. S. Common amongst elm, Redland; Leigh Woods, &c.

" ALNETELLA. S. Amongst alders near Bristol, Stapleton, &c.; not common.

" AURELLA. F. Larvæ plentiful in bramble leaves everywhere. Mr. Vaughan says—"Also in leaves of *Geum urbanum*."

" RUFICAPITELLA. H. Common amongst oaks near Almondsbury; and in Leigh Woods.

" LUTEELLA. S. Plentiful amongst birch in Leigh Woods, Portishead, &c.

" TILIACELLA. F. (=TILIÆ. S.) Stainton says—*N. H. Tineina, VII., p.* 168—"In this country this has only been noticed in the neighbourhood of Bristol." The larvæ are plentiful in leaves of lime in the Leigh Woods, being full fed at the end of July.

TRIFURCULA SQUAMATELLA. S. Stoke Park, Almondsbury; Brislington, on rough ground, flying at dusk.

" IMMUNDELLA. Z. Stoke Park, Almondsbury, Stapleton; Brislington, &c. Mr. Grigg bred some from orange-coloured larvæ found on broom in Frome Glen, Stapleton.

" PULVEROSELLA. S. Taken by Mr. Vaughan near Brislington. No recent records.

PTEROPHORI.

PLATYPTILIA OCHRODACTYLA. H. (=DICHRODACTYLA. M.) Scarce amongst tansy on the banks of the Avon; and near Leigh and Portishead.

„ BERTRAMI. R. Scarce amongst yarrow at Almondsbury; and near Portishead.

„ GONODACTYLA. S. (=TRIGONODACTYLUS. H.) Plentiful in all stages amongst coltsfoot on railway banks, &c.

AMBLYPTILIA ACANTHODACTYLA. H. Not scarce on ivy-bloom and flowers during the autumn, near Clifton, Westbury, Almondsbury; Leigh, &c.

„ PUNCTIDACTYLA. H. (=COSMODACTYLUS.) Scarce in July and August, near Bristol, Redland, Almondsbury, &c. The larvæ are said to feed on *Aquilegia*, a plant common in the district.

OXYPTILUS TEUCRII. G. (=HIERACII. St. *not* Z.) Common amongst wood-sage in June, near Durdham Down, Almondsbury; under Leigh Woods, Brockley Coombe, &c.

„ PARVIDACTYLUS. H. (=OBSCURUS. Z.) Not scarce on the slopes of Durdham Down, near Woodchester, Almondsbury; Leigh Down, Portishead, &c., in June.

MIMÆSEOPTILUS BIPUNCTIDACTYLUS. H. (=SEROTINUS. Z.) Not scarce on downs and amongst scabious, near Bristol, Clifton, Almondsbury, Woodchester; Leigh, Clevedon, &c.

„ ZOPHODACTYLUS. D. (=LŒWII. Z.) Not scarce amongst centaury on Leigh Down, &c. I have not yet succeeded in finding larvæ, which should be looked for in September.

MIMÆSEOPTILUS PTERODACTYLUS. L. (=FUSCUS. S.) Plentiful amongst *veronica* and in strawberry-beds. The larvæ are easily found, and not difficult to rear.

ŒDEMATOPHORUS LITHODACTYLUS. T. Common amongst fleabane in August, on which plants the larvæ may be found in July.

PTEROPHORUS MONODACTYLUS. L. (=PTERODACTYLUS. S.) Common throughout the district in the autumn; partial to ivy-bloom.

LEIOPTILUS TEPHRADACTYLUS. H. Plentiful amongst golden-rod in the Leigh Woods, and on the Portishead railway bank. The larvæ are common on *solidago*, and are easily reared.

„ OSTEODACTYLUS. Z. Not scarce amongst golden-rod in Leigh Woods, in July.

„ MICRODACTYLUS. H. Larvæ common on hemp-agrimony, near Durdham Down; in Leigh Woods, Portishead, &c.

ACIPTILIA GALACTODACTYLA. H. Larvæ abundant on burdock in woods near Bristol, Almondsbury, Woodchester; Leigh Woods, Brockley, &c. Imagines never found flying.

„ BALIODACTYLA. Z. Scarce on Durdham Down, and Woodchester. The larvæ used to be common on marjoram under St. Vincent's Rocks.

„ TETRADACTYLA. L. Not scarce on Durdham Down, Almondsbury, Woodchester; and Brislington.

„ PENTADACTYLA. L. Common throughout the district in June and July. I have never met with the larvæ which are said to feed on convolvulus.

ALUCITA POLYDACTYLA. L. Plentiful amongst honeysuckle throughout the district, in gardens and hedges.

Having now completed the list of our local Lepidoptera, a few remarks on some of the species contained in it may be of interest. Compared with other districts of similar extent of which local catalogues have been published, it will be seen that ours is tolerably rich in species.

In the introductory remarks printed in the first part of this Catalogue, it was stated that Mr. Barrett's list of the Lepidoptera of Norfolk would be taken as a model for this; as the district there treated of is only slightly larger than our own, it may be of interest to compare the species contained in the two Catalogues.

Our list of 55 butterflies includes all those recorded for Norfolk and the following additional species, viz.—*P. Daplidice, L. Sibylla, L. Arion, Adonis, N. Lucina,* and *H. Comma.* In the *Nocturni* we have 73 species as compared with 74; we miss several of the Norfolk fen species, but have others not found there. There are 208 *Geometre* in our list, while the eastern county only numbers 188, most of our additional species being found in our woods and on our lime-stone downs. The *Depanulæ* and *Pseudo-Bombyces* combined number respectively 25 and 24, the extra species in our list being our Leigh Woods "*Hook-tip,*" *D. Sicula.* Of the *Noctuæ* we have 215 Bristol species against 223 in Norfolk; in this group the absence of fenland may chiefly account for the fact that no less than 35 of the *Noctuæ* recorded by Mr. Barrett have not yet been noticed in our district, but as we have 27 species not in his list, the numbers are as above.

In both lists the *Deltoids* and *Aventiæ* combined number 10, the species being the same. Of the Norfolk *Pyrales* 5 are absent from our list, but as we have 9 not found there the totals are 47 to 44. The absence of fenland is again shown in our list of *Crambites*, 19 of the eastern species not being found here, but as we have 7 species not included in the Norfolk list, the numbers are 42 to 54. Of the *micros* we have 205 *Toctrices*, 410 *Tineina*, and 20 *Pterophori*, as compared with 200, 360, and 20 respectively recorded by Mr. Barrett, leaving a balance of 55 species in favour of our western district. This seems to show that the *Microlepidoptera* have had more attention given to them here than in the eastern county, principally owing to the exertions of Messrs Sircom, Hill, Vaughan, and Grigg, without whose aid our list would have been poor indeed.

The recently published list of Yorkshire *Lepidoptera* contains many more species than our own, which is only natural, the area being about six times greater. The totals are Yorkshire 1341, Bristol district 1310, Norfolk 1246. It thus appears that our western Lepidoptera are fairly representative. There are a few species, including *Drepana sicula*, *Miselia bimaculosa*, and some *micros* which have only hitherto been found near Bristol; of too many of the species recorded in our list only single specimens have been found in the district, some of them not having been noticed for many years past. No doubt systematic collecting in the marshy country to the south of our district would give us many additional species. Some few of the fen species have been found there; why not many others? The district between Axbridge, Wells, and Glastonbury ought to be well worth the attention of some of our western entomologists; many plants are found there which do not grow in other parts of the district, and doubtless numerous entomological "good things" would fall to the lot of an energetic collector who would pay a visit to the locality at the right season of the year.

Flora of the Avon-Bed.

By JAMES W. WHITE.

THE occasion must indeed be rare on which the naturalist discovers an object of interest in one of those Avon-side limestone quarries which so detestably disfigure our lovely scenery. This narrative of such an improbable occurrence will tend to support the adage concerning the happening of the unexpected.

One of the largest of the eyesores alluded to is that known as the Black Rock Quarry, on whose verge runs the fence and the promenade called the Sea Walls, on the most elevated part of Durdham Down. At this point stone has been removed from the side of the gorge until the excavation resulted in a perpendicular cliff nearly four hundred feet high. When a continuance of blasting bid fair to endanger the security of the wall and road on the Down above, and the depressed floor of the quarry had become deeply flooded in wet seasons, stone-getting proved hazardous, and was finally discontinued at this spot four or five years ago.

About that time the Dock and Harbour authorities bestirred themselves vigorously to improve the navigation at the port by deepening the water-way at various points, and a large quantity of accumulated deposit was dredged up both from the bed of the Avon and from the floors of the Basins. It no doubt was a difficult problem how to dispose of the dredgings, but the idea occurred to some one that the disused quarry was just the place in which to deposit a large mass of such material. Accordingly a staging was erected on the river-bank, the barges were brought alongside, and by means of steam cranes and tramways some thousands of tons of dredgings were tipped into the quarry. The bulk of the matter scraped up from the bed of the river was broken limestone and alluvial mud, with a good proportion of town and ship rubbish, potsherds, brickbats, and bones of past generations of domestic animals who had been consigned to a watery grave. From the Basins came also a quantity of ashes and refuse thrown overboard from the ships in harbour. All this was tipped from the trams by manual labour until the bed of the quarry became raised above the level of the tow-path, and then the trams were hauled up the incline by steam-power, men continuing to distribute the contents, and no horses were employed on the work. The limestone rubble and heavier matters of course remained where they were thrown, but the semifluid mud flowed lava-like into untouched recesses and depressions of the surface. In this way a space of about half an acre was covered with dredgings to a depth of from ten to twenty feet, and then it was necessary to cease operations in order that the mass might drain and settle before making further additions. This brings us to the winter of 1882. As time went on and the spring advanced, the soil, now drained and washed free from salt by the rains, became firm enough to walk upon. Very shortly I was surprised to notice the appearance of a profuse and varied vegetation, both on the stony rubble-heaps and on the softer alluvium around; and as this developed, surprise gave place to wonder at the interesting character and strange luxuriance of the plants which during the summer successively came into prominence. Attentive periodical examinations of this botanical El Dorado revealed the presence of many species native on the banks of the Avon above and below Bristol, but not heretofore found at or near this spot, viz.:—

Ranunculus sceleratus
Senebiera Coronopus
S. didyma
Sinapis arvensis
S. nigra
Nasturtium sylvestre
Lepidium ruderale
Cochlearia anglica
Diplotaxis muralis
D. tenuifolia
Malachium aquaticum
Erodium cicutarium
Trifolium fragiferum
Medicago denticulata
M. maculata
Melilotus officinalis
Vicia angustifolia
V. hirsuta
Apium graveolens
Conium maculatum
Helosciadium repens
Sedum acre
Centranthus ruber
Artemisia vulgaris
Erigeron acris
Helminthia echioides
Tragopogon pratensis
Aster Tripolium
Tanacetum vulgare
Solanum Dulcamara
S. nigrum
Symphytum officinale
Veronica Beccabunga
V. Anagallis
Linaria minor
Scrophularia Balbisii
Plantago Coronopus
Chenopodium rubrum
C. album
Atriplex angustifolia
A. hastata
Suæda maritima
Salicornia herbacea
Triglochin maritimum
Poa compressa
Sclerochloa procumbens
Bromus madritensis.

There were also some species formerly recorded to grow in the Avon valley, but which latterly have become extinct or extremely rare, viz.:—

Erodium moschatum
Medicago minima
Polypogon monspeliensis
Gastridium lendigerum.

A few British plants (chiefly maritime), not before noted in the Bristol district, viz.:—

Vicia lutea
Ajuga chamæpitys
Echinochloa Crus-Galli
Chenopodium hybridum.

Also the various cereal grasses,—wheat, barley, oats, and rye, with other grasses grown as fodder for animals, all which are, or have been, brought by ships into the port of Bristol; as well as sundry weeds of cultivation presumably companions of the cereals just mentioned, and from the same source, viz.:—

Papaver Rhœas
Thlaspi arvense
Sinapis alba
Lychnis Githago
Centaurea Cyanus
Setaria viridis
Bromus arvensis
B. secalinus.

And lastly, aliens and casuals from all quarters of the globe, viz.:—

Saponaria Vaccaria
Trifolium hybridum
Melilotus alba
Cucurbitus maximus
Centaurea melitensis
Amsinkia sp.
(South American)
Polygonum Fagopyrum
Cannabis sativa
Phalaris canariensis.

It will be at once perceived that many of the species named are to be regarded with interest, not because they are rare, but rather on account of their unexpected appearance in such a peculiar situation. The luxuriant dimensions of most of the plants is worthy of remark. Some stems of *Bromus madritensis* were three feet high, and bore panicles as big as one's head; while a single root of *Sclerochloa procumbens* would overspread a square yard of ground with its radiating branches.

And now let us enquire by what means came such a large number of plants to spring up spontaneously in this remarkable manner. How were they produced? From seed certainly: but whence came the seed? Before the dredged up mud and stones were deposited the quarry was as bare and desolate as crowbar and powderblast could make it. The progenitors did not flourish on the limestone cliffs around, nor on the breezy downs 400 feet above. The adjacent riverbank knew but one or two of them. I made repeated enquiries of the men employed in the work, whether ballast or dry rubbish of any kind had been handled by them, and was always assured that they had been engaged solely with material dredged from the bed of the river and from the Float. Further, no horse fodder had been brought to the spot: steam power and manual labour being alone made use of. Thus we are driven to the conclusion without an alternative that the seeds of all these plants were contained in the soil at the time of its deposition; that they had been lying embedded in the Avon mud, it may be for ages, without losing their vitality; and that notwithstanding their long submersion they had been ready to spring into life when at length the favourable opportunity offered, and they became exposed to the vivifying action of the sun and air. And on consideration of the whole subject of the vitality of seeds, I believe this hypothesis will not prove at all far-fetched and improbable, as it may at first appear to be.

It is absolutely certain that seeds, under widely differing circumstances, may and do preserve their vitality for a long period. Although the well-known statement that wheat taken from an Egyptian mummy-case germinated on being planted, proves not to be well authenticated, there are other instances on record quite as remarkable. The fact of raspberry seeds growing, which had been taken from the skeleton of a human being buried in a tumulus in Dorsetshire, has been doubted; but it was authenticated by Dr. Royle, who was present when the original mass of matter taken from the interior of the body was brought to Dr. Lindley in London, and the seeds discovered in it. He vouched for the correctness of the statement that the seeds which had thus been swallowed and buried had germinated after the lapse of centuries.* A still more remarkable case is the discovery of seeds twenty-five feet below the surface of the earth, in the lowest layers of a sand-pit in process of excavation in the Tweed valley. Upon being sown about a tenth germinated and produced plants of Polygonum, Rumex, and Atriplex.† It was concluded upon various considerations that those seeds were deposited at a period when the valley was occupied by a lake; and if this be the case they must have retained their vitality during many centuries at least, as it is certain that in the time of the Romans no lake existed there. Again, one of the most extraordinary appearances of strange plants ever noticed was recorded at Shipston-on-Stour, Worcestershire.‡ Shipston is situated upon the lias, a geological formation generally considered to have been deposited in a shallow sea, and abounding with shells. A well having been sunk in this, the next year a quantity of *Glaucium luteum* appeared upon the rubbish thrown out from the shaft. No Glaucium had previously grown anywhere in the neighbourhood, and it seems impossible to conceive that the seeds could have got there from the *present* sea-shore. They had possibly remained inert from the time when the deposition of the lias took place, and upon their exposure to the atmosphere were recalled to life. Of course the sea-poppy did not continue to flourish in such an inland position.

In October, 1844, Mr. George Fitt published in the *Phytologist* some facts which strongly support this contention. He observed that *Chenopodium botryoides* sprung up in the greatest profusion and beauty where mud had been thrown out of ditches. He accounted for its sudden appearance by supposing that the seeds lay at the bottom of the ditches preserving their vegetative power until a favourable opportunity offered for them to grow, when cast out with the mud. It has also been noticed by observers in other parts of the world when new soil is turned up, excavations made, and forests burned or otherwise cleared, that plants previously unknown in the locality spontaneously appear, which is a proof that the seeds of such plants must have lain dormant for very lengthened periods.

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* *Phytol.*, vol. iv., 776.

† *Annals and Magazine Nat. Hist.*

‡ *Phytol.*, vol. iv., 132.

Among the conditions requisite for germination is a free supply of air, or at least of oxygen ; so that seeds cannot germinate when buried deeply in the soil, or when that soil is impervious to the air, and this explains how it is that seeds may lie quiescent at great depths, and only germinate when brought to the surface.

Positive evidence from direct experiment is not wanting to a certain extent, although the inferior longevity of man forbids the supply of exact proof. However, seeds of plants preserved in herbaria have germinated after more than a century had elapsed since they were collected ; and the seeds of Leguminosæ especially have been observed to retain their vitality for many years. That natural order is well represented in the list of plants mentioned in this paper.

From the evidence that has been advanced, it seems clear that all the plants under notice sprung from seeds buried in, and dredged up with, the Avon mud. We will now endeavour to ascertain the sources from which these seeds originally came.

As regards the native species whose representatives still hold their ground on the banks of the Avon, it can readily be understood that many of their seeds must necessarily be shed upon the stream, washed to and fro by the tide, and eventually be entangled and buried amid the shifting mud-banks.

Greater interest attaches to that section which represents species formerly found in the Avon valley, but of late years extinct or nearly so. We have here as it were a throw-back to the ancient Flora of the district; descendants from aborigines that have been elbowed out and exterminated by various influences, but whose seeds survived their disappearance, and at length gave rise to progeny, born out of due time for our edification. The magnificent grass *Polypogon monspeliensis* has been hitherto connected with the Bristol Flora solely on faith in a communication ("Near Bristol") made by Miss Alice Worsley (afterwards Mrs. Russell) to Mr. Hewett Watson, and published 1835 in his "New Botanists' Guide." Although regarded, and perhaps with justice, as merely a casual in those days, the circumstances under which it was gathered being unknown, its re-occurrence last year goes toward showing that it may formerly have been a native inhabitant of the Avon valley.

The claim of *Medicago minima* for recognition as a Bristol plant is also extremely slender. A specimen in my possession testifies that it did grow here a generation or more ago; and it is a curious coincidence, if nothing more, that I should find it with the Polypogon in the Avon-side quarry. I have no evidence that this Medick was ever abundant about Bristol, or that it has been seen at all during the last twenty years.

As regards the origin of the Erodium and Gastridium, however, there is less room for speculation. Until quite recently they undoubtedly held their places amid the *dêbris* at the foot of the rocks near the river-side. Although I am inclined to think that the former plant has been extinct for some years, the latter still lingers on in a spot within half a mile of the quarry, but in quantity so small that close search only discloses a sparse annual crop of three or four plants; a flickering existence that must soon terminate unless it gathers new life and vigour from the revival under notice.

There is no difficulty in accounting for the presence of the cereals. I take it for granted that in landing cargoes of foreign grain a portion would always be consigned to the bottom of the Float.

Again, the most perfect threshing machinery in use at home or abroad will not separate from the cleaned grain the seeds of all the humble weeds which make a home between the furrows, and are harvested with the corn, either by the sickle or the still less discriminating reaping-machine of the last decade.

Lastly, it is obvious that the continual presence in our harbour of vessels laden with merchandise from all parts of the globe amply suffices for the introduction to the Avon-bed of the seeds of those stragglers whose names appear in the concluding section of my list.

Meanwhile the dredging has recommenced, the barges and steam cranes are busy with fresh material, and, as I write, the space which for one summer was alive with luxuriant vegetation, is being deeply buried under more seed-bearing soil of like composition.

Bye and bye, when a season of rest is again reached, I do not doubt that another motley throng of curious weeds will arise to excite our interest, and to claim attention from a botanical chronicler.

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Report on Wells Sunk at Locking, Somerset, to Test the alleged Power of the Divining Rod.

BY PROF. W. J. SOLLAS, D.SC., F.G.S., FELLOW OF ST. JOHN'S COLLEGE, CAMBRIDGE.

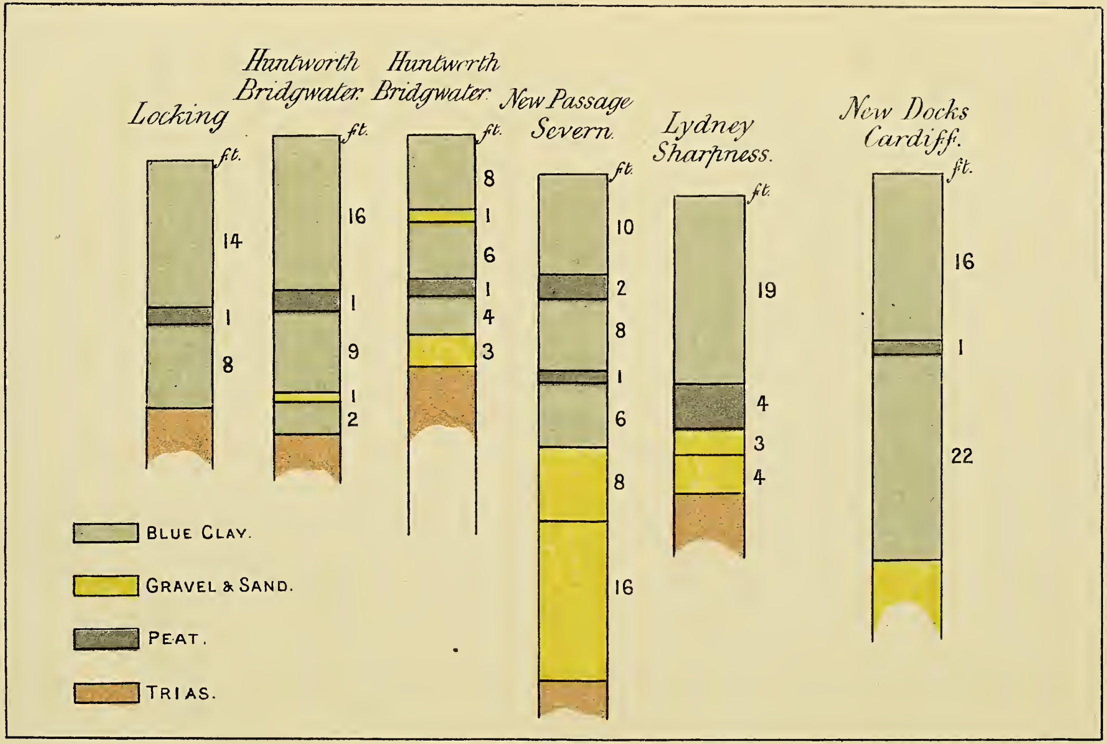
IN response to an invitation I made one of a party of investigators, who on the 14th of May, 1883, proceeded to the little village of Locking, to conduct an inquiry into the alleged phenomena of "dowsing," "rhabdomancy," or divining for water. Our party consisted of Dr. Burder, the esteemed President of the Bristol Naturalists' Society, a lady who was believed to possess the power of divining, Mr. Pope, Mr. Pease, and others. I accompanied them as a professional geologist to determine the geological conditions under which the experiments were to be made.

At Locking we were introduced to the "dowser," Mr. Thomas Young, an aged and experienced man, who for fifty years had been engaged in finding underground water, and with admitted success. He showed us the whole *modus operandi* of his art; and we were told to particularly notice that, at the critical moment, the dowsing rod turned of itself, without any pressure being exerted by the fingers of the dowser; on this point, however, it was the general opinion that the dowser was mistaken. Dr. Burder and myself are positive that every time the rod turned we plainly discovered a corresponding movement in the fingers of the dowser. Not only Mr. Young, but Mr. Lawrence, a dowser of great local reputation, lay great stress on the fact, as they assert, that the movements of the rod are not governed by the movements of the fingers, and also that it turns independently of their volition, in fact, even in spite of their willing to the contrary. As to their volition of course I am unable to speak, but I am confident, from what I observed, that the sole immediate cause for the turning of the rod is to be found in the muscular contractions of the hand of the operator.

We found Mr. Young very frank and communicative ; one of his statements was to the effect that when the dowser walks backwards over the water he is in search of the rod turns downwards, while on walking forwards, it always turns upwards ! A psychical fact so extraordinary that it seems worth while to put it on record. Mr. Young showed a close acquaintance with the ways and habits of underground water. He told us that in the district about Locking it always flowed from east to west ; moreover he actually showed us the natural spring from which the underground water issued which he had previously sunk upon at a point nearer its source, to obtain a supply for an adjacent farmhouse. With so much real knowledge the use of the " rod " seemed superfluous, so I ventured to inquire whether he would regard it as morally wrong to make use of his evidently practical knowledge to assist him in the discovery of springs. He replied, certainly not, but that " he would be nowhere without his rod."

We were now to put the dowser's skill to a practical test. A field on the alluvial plain, which extends from Locking to the Bristol Channel, was selected for the experiment, and on this the " dowser " was to indicate two spots, one beneath which water should be found, and another where it should not. Through these spots shafts were then to be sunk, and the prediction verified or not. In order to simplify the conditions of the experiment, Mr. Pease requested the dowser to operate blindfolded, but to this he absolutely refused to consent. This was very unfortunate, as the trial became one rather of the skill of the dowser than of the truth of dowsing: and I noticed during the trial that the dowser made very good use of his eyes. Looking about, he walked direct to one side of the field, without using his rod;—not wandering as one might have expected, rod in hand, hither and thither, in blind search for an indication. Arrived at the place he had chosen he used the rod over a line of march some 20 or 30 paces long, and as he did so the rod plunged vertically upwards at a spot where he then asserted water would be found. He repeated the traverse further down the field, in the same manner and with the same result. This he did again and again, and so produced the impression that a stream of water was flowing towards the sea beneath our feet, and along a line indicated by the successive points which he indicated by the rod. We therefore asked him to dowse along the length of the stream instead of finding points over it by traverses, and this he very willingly did, walking in an undulating manner over what he gave us to understand was the course of the stream. Finally, we requested him to make a fresh traverse and to indicate the spots where digging was to be commenced. He did so, and at our suggestion selected a place about 20 paces to the north of a ditch or "rhyne" which flows through the flat, as that where water would be found, and another 15 ft. north of this, where he stated it would not.

We determined the position of these places in a way that left no possibility of changing them, and made arrangements for pits to be sunk by the dowser and his assistants. The supervision of the work as it proceeded was deputed to me.

Locking
ft.
Huntworth Bridgwater.
ft.
Huntworth Bridgwater.
ft.
New Passage Severn.
ft.
Lydney Sharpness.
ft.
New Docks Cardiff.
ft.
BLUE CLAY.
GRAVEL & SAND.
PEAT.
TRIAS.

Before proceeding further with an account of the experiment we may consider the nature of the case we are about to try. It is the prediction of a practical man, skilled by experience, opposed to that drawn from the generalisations of science.

The dowser predicts that in one of the pits now to be sunk we shall find water, let us call that the + well ; in the other we shall not, we will call that the – well. As a geologist I predict that we shall find water in both or neither. The dowser does not give reasons for his prediction ; for mine they are the following.

The field we have selected for the experiment is part of the great alluvial flat which borders the eastern side of the Severn and Bristol Channel. Sinkings have frequently been made in various places through this flat, and have revealed the nature and arrangement of the sediments composing it. As a rule (*vide* comparative sections of Plate) the upper 15 or 20 ft. of the alluvium consists of fine silt or clay, beneath which lies a bed of peat of variable thickness ; this is underlaid again by silt, which at a depth of 20 or 30 ft. contains a large proportion of sand, sometimes, indeed, consists altogether of sand ; and beneath this, finally, gravel is frequently encountered, but not always, for the distribution of the gravel is very irregular, so much so, that it is impossible to predict whether it is absent or present below any particular spot. Beneath the alluvial deposit any of the older rocks may be found ; in the case of that at Locking it is almost certain, however, from the structure of the country, that the “ bottom ” rock is Triassic.

The pervious beds of gravel always contain water, and if the sinkings at Locking enter this rock, water will assuredly be found. If not, it will not be obtained in large amount. It is unlikely, however, that gravel should be found in the + well and not in the – well, which is only 15 ft. distant. Still, considering its irregular and “ patchy ” distribution, there is just a chance it may; and on the whole it is, perhaps, more probable that the gravel should be found beneath the alluvium nearer the existing "pill" than farther away from it. For the gravel was probably deposited by a river, and the course of that river might not have been far distant from the present pill, though below it. This, however, is an extremely hazardous hypothesis, on which, without further knowledge, I should not like to risk any of the practical concerns of life. The probabilities are certainly altogether in favour of gravel being found in both or neither of the wells.

As to the sand it is not highly pervious, and though it certainly would yield some water, yet one cannot predict from it a large amount. The sand will almost to a certainty be struck in both wells,—it would be most extraordinary if it were not,—and thus some water may confidently be predicted from both.

Gravel may possibly be reached, and if in one, probably in both wells, and then both will yield water freely.

I now proceed to give an account of the observations made on the wells, as I visited them from time to time during their sinking.

May 22nd. Verified the positions of the wells. The + well had been sunk 10 ft., and contained 6 ft. of water; the – well had been sunk 5 ft., and contained 1 ft. of water.

June 1st. The + well was now 16 ft. deep, and contained a good deal of water, eight or nine feet; water was still trickling in from the sides. As work had been suspended in this well, water had had time to accumulate. The – well was 20 ft. deep, and contained 4½ ft. of water. Water was trickling into it, but not so fast as into the other. The well-sinkers said that this 4½ ft. was merely surface water. A bed of peat 14 ft. from the surface had been struck in both wells.

June 15th. Visited the wells, but found that the work of sinking was suspended. The + well indeed had been abandoned owing to the caving in of the sides. The – well had been timbered down to 20 ft.; it was 22 ft. deep, and water was slowly dripping into it.

June 18th. Received a letter from Mr. Hellier, the bailiff of the estate, stating that the real depth of the + well was 17 ft. 6 in., and the depth of the water in it 9 ft. The – well 20 ft., with 4 ft. 6 in. of water (these numbers are for Friday, June 15th).

June 24th. Commissioned my friend and pupil, Mr. F. P. Evans, to visit Locking. He reported that the water stood in both wells at precisely the same height, viz., 5 ft. 4 in. below the level of the field. So that the + well contained 12 ft. 2 in. of water; the – well 14 ft. 8 in. of water.

The reports from the 16th June to the 24th require some comment. On Thursday, the 14th, the men were sinking, consequently on that day the – well was dry; on the 15th, Friday, work having ceased for 24 hours, it contained 4 ft. 6 in. of water; on Saturday, the 24th (and may be several days earlier), it contained 14 ft. 8 in. Thus the well which should not have furnished any water could not by any perversion of language be called "dry."

June 28th. Mr. Hellier writes, saying that the men have sunk through the clay and found black sand, in which they have sunk 8 ft. On making a subsequent visit I found that this black sand was a fine arenaceous clay.

July 9th. Visited Locking unexpectedly. I was expected to inspect the wells on the previous Saturday. Work had been suspended, but one of the sinkers, George Gale, was still there. He told me that they had been sinking on Saturday, the 7th, and had "kept the water down for me to see everything!" On the 8th, Sunday, water, so he said, had accumulated to the extent of about 4 ft.; on Monday afternoon, when I took measurements myself, there were 12 ft. of water in it. So that 12 ft. had accumulated in 48 hours. I made a thorough examination of the shaft, descending as far as the water, and examining the nature of the sides. The deposits passed through were as follows:—

Blue Silt	14 ft.
Peat	1 ft., or 1 ft. 6 in.
Blue Silt, becoming sandy lower down ...	8 ft.
Red Clay (? Trias)	5 ft. or 6 ft.

The sinker told me they had sunk to 29 ft., in which case the red clay would have been penetrated to the depth of 6 ft. If this red clay is Trias, then Trias must be beneath both wells, and the bottom rock being the same in each, the dowser must have calculated on the presence of gravel in the + well, and its absence in the – well, if he made his prediction on scientific grounds.

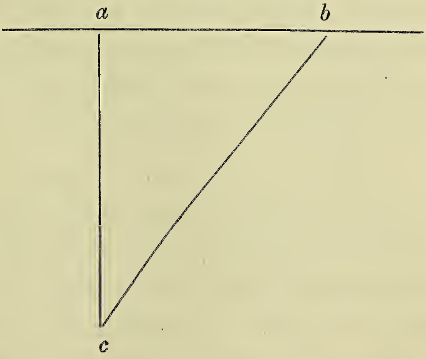
Water was streaming from the sandy sides of the – well just as I had seen it issuing from the sides of the + well on June 1st.

August. Mr. Metcalfe visited the wells for me and found the water standing at the same level in each.

This record of observations seems to me to completely verify the prediction made on the scientific side that the behaviour of the two pits with regard to furnishing water would in all probability be the same for each. The dowser attributed the water in the – well to an outflow from the +, but this is of course an excuse made after the trial had been completed, under conditions to which he had himself assented; and an excuse which is without any rational basis. For if the rock between the – and + wells is so porous that water can stream through it from one to the other (and the increase implies this), then the rock between the two, and necessarily surrounding the two, will be water-bearing, and would furnish water to both, and thus would have supplied the – well if the + one had not existed.

The tenant who farms the estate said he had *seen* the water flowing from the + to – well! The dowser and his assistants confined themselves to asserting that it went into the – well from the side nearest the + well, as indeed, from my own independent examination, I can confirm it did; at the same time it trickled in from the other sides, that farthest off included, quite as freely.

To me, therefore, it appears that the case of the dowser has conspicuously failed, and I attribute it to the fact that the dowser's experience has throughout been gained and employed in the finding of *water*, not in seeking for dry places. As to his ability to discover underground water, these experiments simply confirm general testimony which is unanimously in favour of his powers. That these powers are totally independent of the use of the rod is, I think, proved by the following considerations. For the sake of argument, let us assume that the dowser is psychically affected by the presence of water beneath his feet. The action between him and the water will take place in a straight line, drawn from him to it. On the analogy afforded by physical forces, the force of the action will vary directly as the mass of the acting bodies and inversely as the square of the distance. Let a be the + spot marked by the dowser, and b the – spot, distant from each other 15 ft. Let c be the position of a stream of water, 20 ft. vertically below a.



Join c, b.

Then the action at a will be $\frac{m}{a\,c^2} = \frac{m}{400}$, and at b $\frac{m}{b\,c^2} = \frac{m}{576}$.

So that if the action at *a* be represented by 1, at *b* it will be $1-\frac{11}{36}$ or about $\frac{2}{3}$.

Now, if a force of 1 causes the rod violently to assume the upright position, surely one of $\frac{2}{3}$ should have some appreciable effect; whereas the rod shows no sign of agitation, remaining quite unconcerned, till *a* is reached.

Again, we have stated the case here far too favourably for the dowser, for the underground water is not all concentrated at *c*; it is diffused throughout the alluvium, the underlying deposits are all moist, and the diffused water will act upon the dowser as well as that concentrated in one place. The action at *a*, therefore, is:—

$1+$influence of the diffused water $=\mathsf{X}$ and at *b*: $\frac{2}{3}+$influence of the diffused water $=\mathsf{Y}$, and the difference between X and Y is much less than $\frac{1}{3}$.

Moreover, on many occasions, the underground spring exists at a much greater depth than 20 ft., and yet affects the dowser when he stands vertically over it. Its influence in these cases must be often *less* than the $\frac{2}{3}$ in our experiment, yet it makes itself decidedly felt.

The dowser is naturally possessed of much mother wit, and he has a large experience of the behaviour of underground water; but his wonderful rod has no more magical power than the gold-headed cane of the medical practitioner of the last century.

Note by Edward R. Pease.

Whilst agreeing fully with most of the conclusions which Professor Sollas sets forth in his very able report, I cannot feel his complete confidence in the conclusive nature of the experiment. In September I went again to Locking, and had both the wells emptied of water. The + well I found now to be a mere hole some 10 ft. deep, whilst the — well was a carefully-timbered shaft 24 ft. in depth. I made minute observations of the rate at which both wells filled with water, but during the course of them the sides of the + well caved in and filled it to the depth of 2 ft. This almost destroyed the value of the measurements, and I was not able to repeat them. But in so far as they have any value, they seem to show that the + well filled more rapidly than the – well, although its depth was so much less. The tenant of the farm told me that the water in the + well was of better quality than that in the – well.

Life-History of
Lithospermum Purpureo-cœruleum, *Linn.*[*]

By JAMES W. WHITE.

THERE are several points connected with the life-history of this most beautiful and interesting plant which hitherto have not been appreciated by botanical writers. This neglect is probably due to the rare and local occurrence of the species, whose habitats lie for the most part in the extreme west of this country, and are scattered over hilly and thinly-populated districts, not readily accessible, and but seldom visited. It is not surprising, therefore, that the writings of descriptive botanists distinctly shew that in some cases dried specimens collected only at the time of flowering have been the material from which the published characters have been derived. In other instances authors have not seen the fruit, and in others again most certainly they cannot have seen the root. Thus we find that not merely are the descriptions in some respects erroneous, but also that the chief feature in the development and propagation of the plant has been overlooked.

From the earliest times this species has been named "The creeping Gromwell"; but although one or two old authors appear to have been correctly informed,* none of the manuals in present use describe the manner in which it creeps, or rather *strides*, over the ground by means of the peculiar arching elongation of the barren shoots, which ultimately produce new individuals by rooting at their tips.

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[*] A large portion of this Paper was published in the *Journal of Botany*, March, 1884.

In the "Manual of British Botany" it is said of this species:—"Barren stems prostrate creeping. . . . Nuts 'silvery white, highly polished, slightly rugged,' rarely produced." It is fair to infer from this description that Prof. Babington had not viewed the living plant, nor yet seen a specimen in fruit.

In the 3rd edition of English Botany we find:—"Barren stems elongate, arching, procumbent. . . . Rootstock slender, woody, shortly creeping, producing arching barren shoots about 1 foot long." This gives the impression that the plant creeps by its roots, and not a word is said in relation to the chief method of propagation; although in the 1st edition of the work Sir J. E. Smith remarks that most of the leafy stems throw out roots, and on that point is more correct than his successor. The poor, badly-coloured figure (E. B., 117) is supplemented in the 3rd edition by a barren, *horizontal* shoot, which, however, does not bear rootlets.

In the "Students' Flora" the description runs—"barren stems creeping, . . . rootstock creeping," without note on the manner in which the "creeping" is effected.

These quotations shew that this Gromwell is believed to have either a creeping root, or prostrate creeping barren stems; and to produce fruit but rarely. I wish, by giving the result of my observations on its growth in Somerset, to supply the deficiencies to which I have drawn attention, and to record the facts that the roots do not creep; that fruits are ripened on every cyme if not in every calyx; and that the barren shoots, which seldom spring from a flowering root, are primarily erect, then high arching, and ultimately root at the tip, often at a considerable distance from the parent; the young plants quickly becoming separated by the decay of the connecting links.

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* "In hac specie, reliquis prociduis et repentibus, caulis ille qui flores sustinet erigitur, et foliis longioribus pallidius virentibus amicitur."—*Raii Synopsis*, 229.

"Lithospermum caulibus decumbentibus radicatis, ramis floralibus erectis."—*Haller Historia*, 596.

Lithospermum purpureo-cœruleum is at home in the warm borders of rocky woods in Somerset, within the area of the Bristol Coal-field, and on that account may be regarded as a Bristol plant. Old woods and coppices of oak, beech, whitebeam, and hazel are frequent on the Mendips, nestling in hollows at the base of the hills, or clothing the flank of some outlying spur. Sheltering amid the coarse herbage and tangling briars on the sunny fringes of these woods, seldom penetrating very far into the shade, nor yet venturing more than a yard or two into the open ground, the handsome deep blue flowers of our plant can be seen abundantly in many places at the beginning of May. The soil is merely fragments of limestone leavened with a little loam, from which the roots can readily be disengaged. The rootstock is small, woody, gnarled and twisted, with comparatively large fibres or branchlets. Its position is more or less horizontal; and, producing shoots only at the apex, it lengthens annually to the extent of the width of the terminal buds. At the early season when the flowers first open, the stems, barren or flowering, rarely exceed a foot in height. They are alike erect, and the inflorescence is compact and half shrouded amid the agglomerated bracts and terminal leaves of the shoot. The cyme quickly elongates and discovers two or sometimes three forks, which continue to lengthen during the summer until the fruit is ripe in October, when the total height of the stem may be two feet on an average, of which the fruit cyme will occupy a third. The calyx segments also grow to about double their original length.

Only half of the twelve to eighteen flowers upon each cyme produce fruit: one or at most two polished porcelain-like nuts being found in each fruiting calyx. These nuts are very persistent and conspicuous on the brown, withered, but erect stems; which when seen the next spring suggest the idea of deserted telegraph poles with unusually large insulators; but on being handled in preparation for the herbarium they detach easily, and can hardly be preserved *in situ*. Meanwhile the barren stems, which are not usually produced from a flowering root (I find that the root appears to produce alternately barren stems and fertile ones, and seldom both in the same season), have also developed, and from their first erect position have loftily arched until in the autumn their tips reach the ground. The terminal portions have already put forth some short stout rootlets, and when these touch the earth they soon take hold, and new plants result. At spots where the Lithospermum is abundant, the ground in October is thickly set with green hoops, about the size and shape of those used in Croquet; although in shade a barren stem will occasionally form an arc with a chord of three feet. As soon as the rooting tip has established itself, the rest of the shoot becomes brittle and decays, as if its vitality had been expended in the formation of the young plant. It will be interesting to investigate the physiological cause of this peculiarly speedy decay of the barren shoot after rooting. A somewhat analagous process takes place in the propagation of the fruticose brambles.

It is also worthy of note that, although the mode of growth I have described is extremely well adapted for rapid extension over large tracts of ground, there exists some subtle climatic or other influence which restrains the plant within the narrow limits I have indicated.

The Theory of certain Indicating and Recording Apparatus.

By Professor H. S. HELE SHAW.

THE author has for some considerable time been occupied, during intervals of leisure, in designing apparatus for measuring velocity, such as anemometers, current meters, etc., and contributed, in 1882, a paper to the Institution of Civil Engineers, in which an attempt was made to treat the question in a systematic manner. It was there shewn that there are two modes of measuring velocity, one or the other of which are employed with all instruments for this purpose. They are—

(1) The conjoint observation of time and space, the ratio of which, if uniform, or of the increments of which, if not uniform, is velocity.

(2) The direct observation of the effect due to velocity.

It is often of great importance to see at a glance what the velocity is, and for this purpose the second of these modes is almost invariably employed. Cases of its use are seen in pressure anemometers, the d'Arcy gauge, and Pitot tube, the current meter of M. Perodil, and, notably, in a class of speed indicators, of which there are numerous recent varieties, which depend for their action upon the position of a revolving weight or weights.

When the velocity of a moving body is required to be known at a distance, this method has serious objections. Communication is either made by the varying pressure of a column of fluid,

DISK & ROLLER.

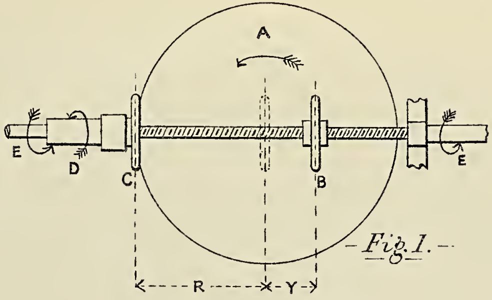

Fig. 1.

0 TO 1 OR 1 TO ∞

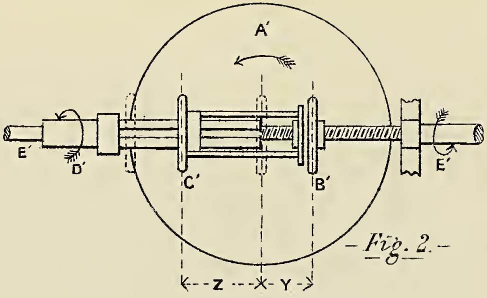

Fig. 2.

0 TO ∞

SPHERE & ROLLER.

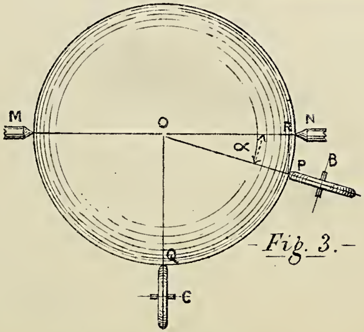

Fig. 3.

0 TO 1, — 1 TO ∞

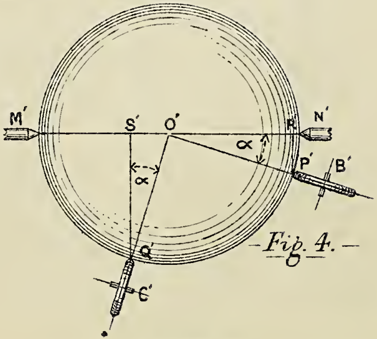

Fig. 4.

0 TO ∞

or by causing the circuit of an electric current to be made and broken with a frequency proportional to the velocity to be measured. The use of a fluid column need not be discussed, it has obvious disadvantages, and, at any rate, has not hitherto been successfully employed where accuracy is necessary and the distance considerable. The use of intermittent action, for maintaining or regulating the continuous motion of a revolving piece in correspondence with it, is a problem which offers great difficulties in its solution, and, indeed, to maintain exact correspondence appears to be impossible.

The first method, viz., conjoint observation of time and space, is employed with surface and subsurface floats on the measured mile, with ordinary anemometers and current meters, or when the body is revolving, with revolution counters. It has great practical advantages when an immediate observation is not necessary, and it can clearly be employed at a distance from the body in motion. There are, however, two obvious defects. The first of these is the time required for the observation; the second is that only the average velocity during the time of an observation is given, the expression for this being

$$\text{Average vel.} = v = \frac{\text{space}}{\text{time}} = \frac{s}{t}.$$

The author has endeavoured to solve the problem of devising an instrument communicated with by a series of intermittent effects, but which should *indicate* continuously the velocity of the moving body. That is, to shew on a dial $v = \frac{\Delta s}{\Delta t}$ where Δs and Δt could be reduced to any required amount by sufficient frequency of the effects.

The following is a theoretical solution :—

Let *A* (*Fig.* 1) be a disk upon which work, by frictional contact, two rollers, *B* and *C*; one of the rollers, *B*, really forms a nut, working freely upon its axis, *E*, as a screw. This axis is made to turn at a speed always corresponding to that of the body or machine whose velocity is to be measured, *i. e.*, corresponding to the frequency of the making and breaking of electric contact. The other roller, C, is fixed to its axis, D, which, for convenience, is hollow, working freely upon the continuation of E, and is turned at a uniform speed by a clock. Suppose, now, both axes to be in motion; the clock, by means of the roller, drives the disk, and thus the other roller, B. If now the speed of the moving body gives a less angular velocity to the screw than the roller, B, derives through the disk from the clock, then B will be screwed by the disk *inwards*, until it rolls upon a smaller circle, and the two angular velocities are equal. If the body gives a greater angular velocity to the screw, then the screw itself will draw the roller *outwards*, until the angular velocity of screw and roller are equal. Thus it is clear that the position of the roller on the disk is a direct measure of the velocity of the moving body. This is easily and conveniently expressed in symbols.

Let ω = angular vel. of screw.
ω' = angular vel. of axis.
R = radius of disk.
y = distance of roller, B, from centre of disk.

Then since the radii of both rollers are equal

$$\frac{\angle^{r}\text{ veloc. of }B}{\angle^{r}\text{ veloc. of }C}=\frac{\omega}{\omega'}=\frac{y}{R};$$

$$\text{or}\quad \omega=y\frac{\omega'}{R}=yK;$$

$$\text{where}\quad K=\frac{\omega'}{R}=\text{a Constant.}$$

Therefore y is a direct measure of ω, that is of the velocity of the moving body, and is independent of the time over which the observation extends. Moreover, it does not matter if the motions derived from both the clock and body in motion are

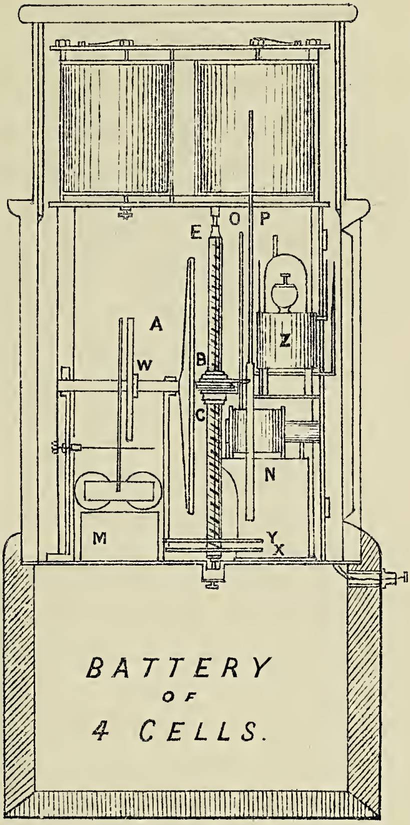

Fig. 5.

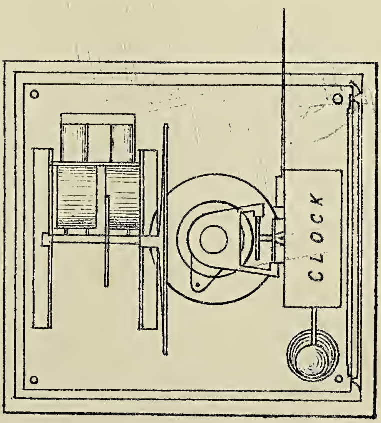

Fig. 6.

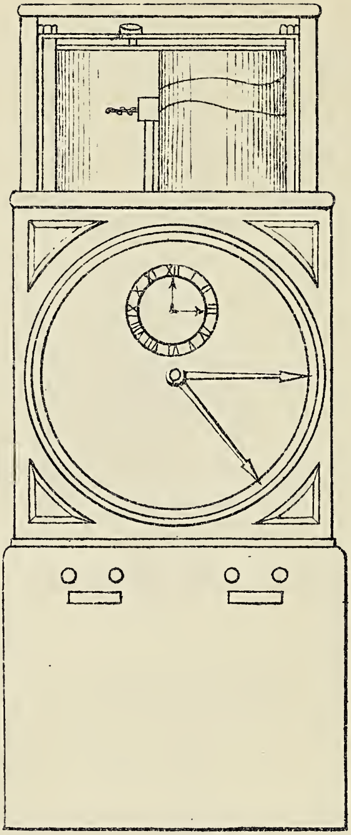

Fig. 7.

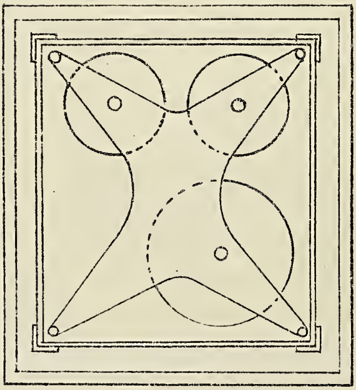

Fig. 8.

intermittent, as it would only mean that there would be a continual oscillation of the roller, *B*, one way or the other to an extent which might be indefinitely reduced. It must, of course, be remembered that the roller, *B*, does not move instantaneously to its new position, but, on the other hand, it does so with a speed which varies in the direct ratio of the change of velocity of the moving body.*

To put these principles into a practical shape, an instrument was devised, in which, for convenience, the axis of the disk is driven directly by the clock. Two rollers are used, but each worked on a separate screw. They are arranged to measure at once the velocities of two different bodies, and not only indicate them both by two separate hands on a dial, but also record them upon a drum. The proposed object of this particular instrument was to record by suitable arrangements the speed of the engines of a ship, and at the same time its velocity through the water. *Figs.* 5, 6, 7, and 8 are different views of the instrument. The disk *A* (*Figs.* 5 and 6) is driven by an electro-magnet, *M*, and ratchet wheel, *W*, the action of which is controlled by the clock, *K*, by means of a special contact maker, *Z*. Two rollers, *B* and *C*, shewn together in their central position in *Fig.* 5, work upon the screws *E* and *D*, the lower one of which is hollow and is driven by the upper ratchet wheel, *Y*, by an electro-magnet, *N*. The upper screw is reduced so as to pass through the hollow one, and is driven in a similar way by the lower ratchet wheel, *X*. From what has been previously said the action of the instrument will be easily understood. The rollers, *B* and *C*, act respectively upon two racks, *O* and *P*, and, by their means, upon the pinions of the indicating hands and upon the recording drum.

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* The author afterwards ascertained that a suggestion was previously made of this mode of measuring velocity by a correspondent in *Engineering*, vol. xx., p. 314.

The above instrument, though working sufficiently well to prove the correctness of the principles upon which it is made, had the serious defects which disk and roller mechanisms suffer from, and which render it difficult to give the disk sufficient speed, so as to obtain a reasonable range of variation of velocity. This led to an attempt to design an instrument which should measure a greater range. The following investigation resulted from this attempt, and though not yet put into a practical form, may possibly be so before long, and was therefore thought worthy of publication.

In the equation $\omega = y\frac{\omega'}{R}$,

when $y=0, \quad \omega=0,$

$y=R, \quad \omega=\omega',$

which shews the range of velocity measured by the first form of disk and roller to be from 0 to ω'.

Suppose, now, the screw is driven by the clock, and the disk by the moving body,

then $\omega' = y\frac{\omega}{R}$,

or $\omega = \frac{1}{y}R\omega'$,

when $y=0, \quad \omega=\infty,$

$y=R, \quad \omega=\omega'.$

The range is in this case from ω' to ∞, but this is not a really convenient range.

Suppose, now, instead of keeping the driving roller, *C*, at one position on the disk, it is connected with *B*, and moves with it as far as longitudinal motion is concerned, as shewn in the arrangement in *Fig.* 2. Then precisely the same action takes place as in the arrangement of *Fig.* 1, except that the screw now draws along both rollers with the evident result of a much more rapid adjustment. Now the formula becomes:—

$$\frac{\omega}{\omega'}=\frac{y}{z},$$

$$\text{where}\quad z=R-y,$$

$$\therefore\quad \omega=\frac{y}{R-y}\,\omega',$$

$$\begin{array}{lll} \text{when} & y=0, & \omega=0, \\ & y=z=R-y, & \omega=\omega', \\ & y=R, & \omega=\infty. \end{array}$$

So that now the range of velocity is from 0 to ∞. The graduation of the scale is not so simple as in the first case, but inasmuch as the arrangement has still the radical defects of the disk and roller, it is not suitable for practical application. The author then endeavoured to ascertain whether there was not some simpler relation between these two forms than appears at first, and with the following result.

Let O (*Fig.* 3) be the centre of a sphere which works on two fixed centres, M and N, that is about the axis, MN. Let Q be the point of contact of the roller C, which works against the great circle of revolution (*i. e.*, the equator) and P, the point of contact of a movable roller, P, working in the figure against a small circle whose radius is PR.

Let angle of plane of B with $MN=a$;

$$\text{Then}\quad \frac{\angle^r\text{ vel. of }B}{\angle^r\text{ vel. of }C}=\frac{\omega}{\omega'}=\frac{RP}{OQ};$$

$$\text{but}\quad \frac{RP}{OQ}=\frac{RP}{OP}=\sin a;$$

$$\therefore\quad \frac{\omega}{\omega'}=\sin a;$$

$$\text{or}\quad \omega=\omega'\sin a.$$

In *Fig.* 4 the roller C is now movable as well as the roller

B. They are both attached to one movable frame, their planes always being perpendicular to each other.

$$\text{Then } \frac{\angle^r \text{ vel. of } B}{\angle^r \text{ vel. of } C} = \frac{\omega}{\acute{\omega}} = \frac{RP}{SQ};$$

but by similar triangles OSQ, ORP, $SQ = OR$;

$$\therefore \quad \frac{\omega}{\acute{\omega}} = \frac{RP}{OR} = \tan a;$$

$$\therefore \quad \omega = \acute{\omega} \tan a.$$

These may be called the "sphere and roller" arrangements or mechanisms. The relation between the two forms of disk and roller are now quite clear. The first is derived from the sine or cosine form of sphere and roller, the second from the tangent or cotangent form.

For in the first case

$$\text{when} \quad a = 0, \quad \omega = 0,$$
$$a = 90^\circ, \quad \omega = \acute{\omega},$$

that is the range of velocity is from 0 to $\acute{\omega}$, and by changing the rollers as before from $\acute{\omega}$ to ∞.

In the second case

$$\text{when} \quad a = 0, \quad \omega = 0,$$
$$a = 45^\circ, \quad \omega = \acute{\omega},$$
$$a = 90^\circ, \quad \omega = \infty,$$

that is the range is as before, from 0 to ∞.

A rough model, with a wooden sphere 6 inches in diameter, which was made, and exhibited very clearly the variations in relative angular velocity of the rollers as their relative position with regard to the axis of revolution of the sphere changed. The side motion of the rollers over the spherical surface on which they have to roll without slipping is a serious practical objection to the use of this arrangement, but it might be advantageously used for educational purposes to find approximately *any* of the trigonometrical ratios and to explain their meaning. Suppose the cosecant of 35° 7′ be required

then in the sine form make $a = 35° \, 7'$.

Turn roller C through one revolution

then number of revolutions by $B = \text{cosec } 35° \, 7'$.

There are, no doubt, other applications, if the practical difficulties of the problem can be overcome.

Rainfall at Clifton in 1883.

By GEORGE F. BURDER, M.D., F. R. Met. Soc.

TABLE OF RAINFALL.

	1883.	Average of 30 Years.	Departure from Average.	Greatest Fall in 24 Hours.		Number of days on which ·01 in. or more fell.
				Depth.	Date.	
	Inches.	Inches.	Inches.	Inches.		
January ...	3·911	3·251	+0·660	0·575	24th	20
February ...	3·995	2·318	+1·677	0·906	10th	19
March... ...	0·952	2·216	−1·264	0·274	19th	9
April	0·859	2·144	−1·285	0·210	18th	9
May	1·576	2·362	−0·786	0·384	25th	13
June	3·107	2·623	+0·484	0·516	15th	17
July	3·672	2·959	+0·713	0·711	20th	17
August ...	2·384	3·595	−1·211	0·913	8th	13
September ...	4·476	3·355	+1·121	0·777	10th	17
October ...	3·424	3·793	−0·369	0·492	14th	13
November ...	4·950	2·856	+2·094	0·775	21st	20
December ...	1·486	2·841	−1·355	0·554	10th	12
Year	34·792	34·313	+0·479	0·913	Aug. 8th	179

Remarks.—The year 1883 presented no such remarkable features in respect of rainfall as its immediate predecessor. Six months out of the twelve showed an excess and six a deficiency, the total for the year being 34·792 inches, or about half an inch above the average.

January and February brought a continuation of the rainy period which marked the close of the previous year. The three following months—March, April, and May—were all unusually dry, yielding together 3·387 inches, a smaller quantity than had before been recorded in the same three months. The driest month of the year was April, with 0·859 inch. The wettest was November, with 4·950 inches.

The longest intervals of drought were in February and March, 19 days; in March and April, 18 days; in the latter part of August, 15 days. Only very small quantities of rain fell in each of these periods.

There was no instance throughout the year of a day's rain amounting to one inch, although this limit was approached on the 10th of February and on the 8th of August.

The year was almost entirely free from snow, the greatest depth noted having been half an inch on the 8th of March. A little fell, however, as late as the 10th of May.

Meteorological Observations, as regards Temperature, taken at Clifton, 1883.

By H. B. JUPP, M.A., F.R. Met Soc.

THE observations from which the following tables are derived have been taken at 8.30 a.m. daily. The Thermometers used, with the exception of that for the Ground Temperature, are kept in a Stevenson cage; and in all the readings the requirements of the Royal Meteorological Society are strictly complied with.

1883 TEMPERATURES.

MONTH.	Maximum in Shade.		Minimum in Shade.		Mean in Shade.	Minimum on Ground, Lowest recorded.
	Highest recorded.	Mean.	Lowest recorded.	Mean.		
January ...	54·4	47·17	30·7	37·41	42·29	25·4
February ...	54·0	48·68	30·1	37·97	43·34	22·2
March ...	55·1	43·66	20·9	30·37	37·01	19·3 *bis.*
April	64·2	55·20	31·9	39·83	47·51	27·2
May	71·2	57·31	29·9	42·54	49·92	30·1
June	74·5	63·98	42·4	50·44	57·21	41·8
July	73·3	61·64	44·7	52·78	57·21	44·8
August ...	82·5	67·71	47·6	53·56	60·63	44·5
September ..	71·9	61·32	43·3	49·38	55·35	37·9
October ...	61·7	54·59	37·9	44·76	49·67	31·7
November ..	56·5	47·43	29·1	38·17	42·80	24·3
December ...	51·9	45·54	28·7	37·37	41·45	24·0
The Year ...	82·5	54·54	20·9	42·88	48·71	19·3

March, 1882	61·5	52·28	30·1	39·16	45·72	25·9
March, 1881	55·9	48·76	25·2	37·17	42·96	18·6

MONTH.	Number of Days on which the Minimum Ground Temperature was below 32°.	Number of Days on which the Minimum Air Temperature was below 32°.	Number of Days on which the Maximum Air Temperature was below 32°.	Number of Days on which the Mean Air Temperature was below 32°.	Humidity in percentage of Saturation. Mean of Values at 8.30 a.m. 1883.	1882.
January ...	13	5	0	0	94	90
February ...	10	2	0	0	88	89
March ...	27	22	0	6	82	89
April	6	1	0	0	76	81
May	2	2	0	0	80	74
June	0	0	0	0	74	76
July	0	0	0	0	76	87
August ...	0	0	0	0	77	93
September...	0	0	0	0	85	82
October ...	2	0	0	0	85	90
November ..	9	3	0	0	86	83
December...	10	5	0	0	88	90
The Year ...	79	40	0	6	82·8	85·3
March, 1882	11	5	0	0	—	—
March, 1881	14	8	0	1	—	—

The chief feature of the year was the exceptional coldness of the month of March, following as it did on a remarkably mild winter.

For comparison, the figures for March, 1882, and 1881, are given at the ends of the columns.

There was no day in 1883 in which the Maximum Temperature failed to reach 32°, as against two such days in 1882, and eleven in 1881.

At the General Meeting of the Society, on March 6th, Mr. Jupp read a paper on "Observation of Climate," with more particular reference to the observations conducted under his guidance at Clifton College, and printed annually in the Proceedings. The methods of taking these observations were described, and also the safeguards adopted to ensure accuracy. In brief, it appeared that every rule of the Meteorological Society is observed, except one: the readings are taken at 8.30 a.m. instead of at 9. The paper dealt with the reasons for these rules, with the merits and demerits of the Stevenson Cage and of Glaisher's Thermometer Stand, and with the value of Humidity calculations. It was decided that these are to be printed in the future. In conclusion, the writer urged that his measures could not be taken as really giving the Climate statistics of Clifton and Bristol, however accurate they may be for the particular locality of their origin—the Botanic Garden of Clifton College. We want, said he, six stations at least distributed over Bristol, and our preserved figures should be the means of six records, all taken under the same rules. Surely there are enough observers to be found; all that is wanted is that they shall conform themselves and their instruments to one pattern. An expenditure of £5 in money once for all, and of ten minutes daily in time is all that is needed. Many people give this time now, and would have no difficulty in finding the money; but for want of conformity their figures are valueless, or at least valueless for preservation. We want to utilise our waste power in Meteorology.

On an Ergometer for Small Electromotors.

ABSTRACT OF A PAPER BY THE REV. F. J. SMITH.

WHEN small electromotors have to be tested, great care should be taken not to introduce any extraneous friction from the instrument employed to measure the work done by them. To obviate this difficulty, the author has devised the following plan, first used by him in testing some Trouvé motors in the year 1881.

The motor as a whole is virtually converted into its own ergometer, or work measurer. The field magnets and frame are balanced with counterpoise weights, so that the whole motor, when the axis of the armature is placed between suitable centres, is in equilibrio ; the bearings in which the spindle of the armature runs are carried on friction wheels, to prevent any unnecessary friction due to the weight of the field magnets and frame. When the motor is doing work the reaction of the armature is against the field magnets and frame. In the figure, B, D are the field magnets, E the armature. If the armature revolve within the field magnets, certain tangential forces, f_1, f_2, f_3, will be tending to turn the frame ABCD and field magnets in the direction of the arrows, and these forces acting at the effective radius will give the moments $f_1r, f_2r, f_3r = \Sigma\, fr$, about the point O, and we have another moment Pd, the whole frame without the weight P is balanced, so that the weight P alone acts at the distance d, when equilibrium in the system is established we have

$$\Sigma\, fr = Pd \quad \ldots\ldots\ldots\ldots \quad [A].$$

Next, take the angular velocity at a unit distance from O, then the work due to the above-mentioned forces for one revolution will be

$$\Sigma fr\, 2\pi.$$

Let n denote the number of revolutions per minute of the machine, and W the work due to friction in a second;

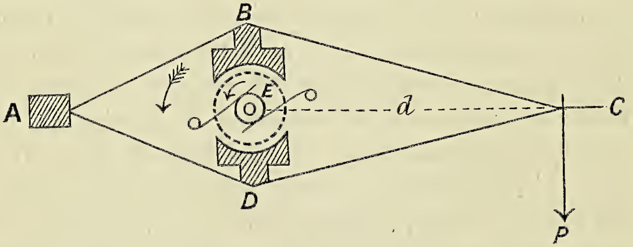
then

$$W = \frac{\Sigma fr\, 2\pi n}{60};$$

put the value of Σfr in (A) into equation B, and we have

$$W = \frac{\pi n}{30} Pd.$$

In this way an electro-motor has become its own ergometer. If the point C be so arranged as to put in or cut out resistances from the circuit, the system may be automatically kept in equilibrio.



By means of a similar method of mounting, a dynamo may be made to take the place of a friction brake ergometer, such as that of Prong. In this case taking out resistance from the circuit will have the same effect as adding pressure in the Prong machine.

The Fungi of the Bristol District.

PART VII.

By CEDRIC BUCKNALL, Mus. Bac.

	LEPIOTA.			
1024.	Agaricus carcharias, *Pers.*	Durdham Down,	Oct.	1883.
1025.	,, polystictus, *Berk.*	,,	Oct.	,,
	TRICHOLOMA.			
1026.	Agaricus albobrunneus, *P.*	Beggars' Bush Lane,	Oct.	,,
	CLITOCYBE.			
1027.	Agaricus inversus, *Scop.*	Hanham,	Oct.	,,
1028.	,, flaccidus, *Sow.*	,,	Oct.	,,
1029.	,, brumalis, *Fr.*	Durdham Down,	Oct.	,,
	PLEUROTUS.			
1030.	Agaricus cyphellaeformis, *B.*	Westridge Wood,	Oct.	1882.
	COLLYBIA.			
1031.	Agaricus acervatus, *Fr.*	Durdham Down,	Oct.	1883.
	MYCENA.			
*	Agaricus pelliculosus, *Fr.*	Leigh Down, Hanham,	Oct. Oct.	1879. 1883.
	Agaricus vulgaris (No. 511) was recorded in error.			
1032.	Agaricus pterigenus, *Fr.*	Leigh Wood, (Miss Dickson),	Nov.	1883.
	OMPHALIA.			
1033.	Agaricus griseopallidus, *Fr.*	Durdham Down,	Sept.	1883.

1034. Agaricus gracillimus, *Weinm.* — Tyndall's Park, (Mrs. Atchley), April, 1884.

Entoloma.

1035. Agaricus sinuatus, *Fr.* Hanham, Sept. 1883.

Leptonia.

1036. Agaricus serrulatus, *Pers.* Durdham Down, Sept. ,,

Psalliota.

1037. Agaricus comtulus, *Fr. Hym. Eur.*, p. 281 ? Durdham Down, Sept. ,,

My specimens differ from Fries' figure in the more elongated stem, and especially in the pendulous, not spreading ring, which is striate, and placed near the apex of the stem. As it may possibly be distinct, and does not appear to be referable to any other species, I append a description.

Pileus fleshy, convex then plane, silky, white, here and there stained with reddish-yellow as well as the fistulose, sub-attenuated stem; ring apical, pendulous, striate, white; gills free, crowded, attenuated towards each end, flesh-coloured then brown.

Pileus 1¼ to 1¾ inches across; stem 1½ to 2½ inches high, 2 to 4 lines thick.

Phlegmacium.

1038. Cortinarius percomis, *Fr.* Durdham Down, Oct. 1883.

1039. ,, anfractus, *Fr.* ,, Oct. ,,

This is the *C. anfractus* of Quelet, and was accepted as such at the Hereford Fungus Meeting of last year, but Dr. Cooke points out that it is not the *C. anfractus* of Berkeley, of which he has an excellent drawing.

1040. Cortinarius calochrous, *Fr.* Durdham Down, Oct. 1883.

1041. ,, prasinus, *Fr.* — Bitton, (C. E. Broome, Esq.), Oct. ,,

1042. ,, papulosus, *Fr.* Durdham Down, Oct. ,,

Pileus fleshy, plane, glabrous, discoid, *soon rivulose*, *granulato-punctate;* stem stuffed, rigid but fragile, fibrillose, white without and within, naked above the fugacious veil; gills adnato-decurrent, crowded, joined behind, pallid then yellowish cinnamon. *Fr. Hym. Eur.*, p. 352.

Stem clothed below with brownish appressed scales. New to Britain.

Myxacium.

1043.	Cortinarius arvinaceus, *Fr.*	Blaize Castle Woods,	Oct. 1882.

Pileus fleshy, soft, expanded, glabrous, viscid, margin spreading; stem tall, cylindric, *silky-viscid*, whitish yellow; gills adnato-decurrent, broad, even, straw-coloured then ochraceous. *Fr. Hym. Eur.*, p. 354. New to Britain.

1044.	Cortinarius mucifluus, *Fr.*	Durdham Down,	Oct. 1883.

Inoloma.

1045.	Cortinarius sublanatus, *Fr.*	Durdham Down,	Oct. ,,

It is doubtful whether *Cortinarius cotoneus* (No. 862) should not be referred to this species.

Telamonia.

1046.	Cortinarius quadricolor, *Fr.*	Blaize Castle Woods,	Oct. 1882.
1047.	,, helvolus, *Fr.*	Durdham Down,	Oct. 1883.
1048.	,, hinnuleus, *Fr.*	Hanham,	Sept. ,,

Hydrocybe.

1049.	Cortinarius dilutus, *Fr.*	Blaize Castle Woods,	Oct. 1882.
1050.	,, castaneus, *Fr.*	Leigh Wood,	Oct. 1883.
1051.	,, colus, *Fr.*	Blaize Castle Woods,	Oct. ,,

Pileus rather fleshy, convex, subgibbous, glabrous, *brownish-red* (paler, shining); stem solid, attenuated above, rigid, naked, *longitudinally fibrilloso-striate*, paler as well as the superior, fugacious veil; gills adnate, plane, rather thick, dark cinnamon. *Fr. Hym. Eur.*, p. 391.

Dr. Cooke identifies my plant as the above species, although the "fiery-red mycelium" mentioned by Fries was not visible. New to Britain.

1052.	Cortinarius leucopus, *Fr.*	Tyntesfield,	Nov. 1879.
1053.	,, decipiens, *Fr.*	Blaize Castle Woods,	Oct. 1883.

1054.	Cortinarius germanus, *Fr.*	Hanham,	Sept. 1883.
1055.	Hygrophorus chlorophanus, *Fr.*	Hanham,	Oct. ,,
*	Lactarius scrobiculatus, *Fr.*	Leigh Wood,	July, 1880. Sept. 1883.

The typical form, which has not been before recorded as British. No. 736 is this species, not *Lactarius chrysorrhaeus.* The pileus was ten inches across.

1056.	Lactarius uvidus, *Fr.*	Blaize Castle Woods, Leigh Down, (Miss Dickson),	Oct. 1883. Nov. ,,
1057.	,, subdulcis, *Fr.*	Blaize Castle Woods,	Oct. ,,
1058.	Marasmius peronatus, *Fr.*	Leigh Wood, (Miss Dickson),	Nov. ,,
1059.	Lentinus cochleatus, *Fr.*	Portishead, (Miss Dickson),	Sept. ,,
1060.	Polyporus caesius, *Fr.*	Leigh Wood,	Oct. ,,
1061.	,, conchatus, *Fr.*	Clevedon ? (Mr. Green).	
1062.	Corticium sanguineum, *Fr.*	Leigh Wood, (Miss Dickson),	Nov. ,,
1063.	Clavaria umbrina, *B.*	Blaize Castle Woods,	Sept. 1882.
1064.	,, cristata, *Pers.*	Durdham Down,	Oct. 1883.
1065.	,, Ardenia, *Sow.*	Leigh Wood, (Miss Dickson),	Nov. ,,
1066.	Calocera viscosa, *Fr.*	Abbot's Leigh,	Oct. ,,
*	Hydnangeum carotaecolor, *B.*	Durdham Down,	Oct. ,,
1067.	Hymenogaster olivaceus, *Vitt.*	Westridge Wood,	Oct. 1882.
1068.	Geaster Bryantii, *B.*	Clifton Down, (L. Rogers, Esq.)	Dec. 1883.
1069.	Chondrioderma radiatum, *Linn. ?*	Glen Froome,	Sept. 1881.
1070.	Myrothecium roridum, *Tode.*	Leigh Down,	Mar. 1880.

1071.	Mucor caninus, *P.*	Durdham Down,	Oct. 1883.
1072.	Geoglossum microsporum, *Cooke & Peck.*	Hanham,	Oct. 1882.
1073.	Peziza onotica, *P.*	Leigh Wood,	Sept. 1883.
1074.	Peziza(Sepultaria)hybrida, *Sow.*	Stoke's Croft, Bristol,(Mr. Green),	July, 1882.

"It must always remain a question of individual opinion as to what is really the *Peziza brunnea*, A. & S., and the *Peziza hybrida*, Sow., and whether both are the same species. Recently Mr. Cedric Bucknall has submitted to us specimens of a *Peziza* which, in our opinion, approximates most closely to the species of Sowerby of anything we had previously seen. It was found growing between paving stones in an area at Bristol. In size attaining three-quarters of an inch in diameter. The disc orange red, but not deep; externally brown, clad with fascicles of rather rigid, straight-pointed hairs (2×·008 m.m.). The nearest approach in the size of sporidia to this species is the *P. umbrata*, Fr. (Mycographia, fig. 137), but here all similarity ceases. The size is very much greater, the external hairs are fasciculate and straight as in *P. gregaria*, and not delicate, and flexuous as in *P. umbrata.* The habit and structure is that of the section *Sepultaria*, and not of *Scutellinea.* The figures given by Sowerby represent the species very well except that the disc is hardly so bright. All circumstances considered, we feel satisfied that it is most probable this is really the missing species. How far this may be regarded as identical with the *Peziza brunnea*, A. & S., may after all, remain doubtful; we are prepared to accept it, meanwhile, as the *Peziza hybrida* of Sowerby."—*Cooke in Grevillea*, vol. 12, p. 43.

1075.	Bulgaria pulla, *Fr.*	Blaize Castle Woods,	Oct. 1882.

Subgelatinous, sessile, glabrous, when young plane, quite entire, olivaceous, afterwards convex and quite black; disc pruinose, pulverulent. *Fries.*

My specimens are on rotten oak, and not more than a quarter of an inch across.

Asci cylindric; spores eight, from subglobose to ovate-oblong, brown, nucleate, ·0004 in. × ·00035 in. or ·0006 in. × ·0003 in.; paraphyses linear, flexuous, slightly thickened above, dark violet, opaque.

Distinguished from *Bulgaria inquinans* by its smaller size, and especially by the violet paraphyses. The asci also contain eight spores, and not four as in the latter species. New to Britain.

1076.	Genea hispidula, *B.*	Hanham,	Oct. 1883.
1077.	Phacidium repandum, *Fr.*	Clapton,	April, 1884.
1078.	Hypomyces rosellus, *Tul.* (Conidia and barren subiculum).	Sandy Lane,	Jan. ,,
1079.	Hypomyces Linkii, *Tul.* Conidia).	Hanham,	Sept. 1883.
1080.	Hypospila (Linospora) viburni, *Bucknall.*	Abbot's Leigh,	April, 1881.

"Epiphylla, sparsa, nigricans. Pseudo-peritheciis convexis, subrugosis, folii innatis, prominentibus, astomis, sub-orbicularis, cellulosis. Ascis cylindraceis, octosporis. Sporidiis stipatis, filiformibus, hyalinis (·16 m.m. long).

"On dead leaves of *Viburnum lantana.* Closely allied to *Hypospila populina*, Fr., and, in the arrangement of Saccardo, it would be placed with it in the section *Ceuthocarpon* of *Linospora.*" —*Grevillea*, vol. xii., p. 44.

1081.	Valsa (Chlorostate) hystrix, *Sacc. Syl.* No. 2416.	Leigh Down,	May, 1881.
*	Cucurbitaria berberidis, *Gray*	Blaize Castle Woods,	April, 1884.
1082.	Sphaeria arundinacea, *Sow.*	St. Philip's Marsh,	July, 1882.
1083.	Sphaeria rostellata, *Fr.*	Leigh Down,	April, 1883.

On dead stems of *Rubus Idaeus.*

1084.	Sphaeria Marram, *Cooke.*	Cheddar,	June, 1882.

Recent Researches on Dynamo-Electric Generators.

By Professor SILVANUS P. THOMPSON.

[Abstract.]

AFTER giving a brief sketch of the earlier machines, illustrated by the oxy-hydrogen lantern, the lecturer pointed out that one of the most important requirements for a good dynamo was that it should give a current of uniform electromotive force, or "electric pressure," no matter how great or how small the resistance in circuit. Thus, if to begin with ten lamps are working, and then nine are turned off, the remaining one should give the same light as before. Till recently, no attempts had been made to obtain a scientific basis for the improvements introduced, but now that state of things was being changed. The first step forward was taken when graphic representation of the work done by a machine was introduced by the construction of diagrams similar to the ordinary indicator diagrams of steam engines, with the difference that vertical distances represent electromotive force, and horizontal distances current. If for *any* current the electromotive force remain constant, then the diagram will be a horizontal line. In the case of a machine giving such a diagram, the brilliancy of the one light mentioned above would be unaltered in spite of altering the current to the extent we should do by turning off the other nine lamps. This has been practically realized by Mordey's modification of the Schuckert machine. In that case, out of 101 incandescent lamps in full operation, 100 were suddenly turned off without altering the light emitted by the remaining one.

These characteristic curves vary in form almost indefinitely, according to the machine used.

Professor Thompson then pointed out that it was of great importance that the distribution of potential in the commutator should be known, and that the current should be led off at the point of maximum potential, returning to the minimum point. In the older machines it was constantly found that this could not be done, since the maximum shifted when the resistance of the circuit was altered. By means of a small coil moveable in a circle between magnet poles, Isenbeck has recently been able to plot out curves showing how the electromotive force produced by moving the coil varies in different parts of the field. In this way a knowledge of the phenomena which take place in such a case has been obtained, and this has been extended by Professor Thompson by integrating the curves over a series of coils such as we have in an ordinary armature. The influence of the material of the core, and of the form of the magnet pole, on the electromotive force has thus been tested, and it is found to be advantageous to have plenty of iron in the armature and to reduce the size and alter the shape of the cheeks of the inducing poles. Experiments similar to those of Isenbeck were performed by the lecturer, and applied by him to illustrate the advantage of iron in the armature.

When external conditions are so arranged that the electromotive force increases regularly in any given coil as it approaches the magnet pole, it is found that the distribution of potential in the commutator also becomes symmetrical, increasing regularly from a minimum to a maximum value, and the current can be led off at these points without difficulty.

Professor Thompson then showed that these points did not occur at the points on the commutator nearest the *magnet* poles, owing to the fact that the armature coil is an electromagnet, and has poles of its own; and consequently the position of the resultant poles influencing it (and therefore of the maxima and minima of potential) is a compromise between the two. In consequence of this, a slight inclination, technically called "lead," in the direction of rotation, has to be given to the brushes, and this "lead" increases with the speed of rotation, since by this the current in the coils of the armature is altered.

On the Primary Divisions and Geographical Distribution of Mankind.

By JAMES DALLAS, F.L.S., F. R. Hist. Soc.,
Curator of the Bristol Museum.

[Abstract.]

THE author stated that the views which he brought forward originated in an attempt to appreciate the divisions and distribution of man suggested by Professor Huxley. He proposed to divide the various races of mankind into three primary groups, for which the following names were suggested :—

Leucochroic Group, of which the white European might be regarded as typical;

Mesochroic Group, represented, amongst others, by the Mongolian races;

Melanochroic Group, of which the Negroes and Negritos might be regarded as typical.

With reference to the last group the author pointed out certain facts tending to prove the former presence of negro-like races in north-eastern Africa, and in Arabia, and referred the Dekkan tribes to a similar origin. He then called attention to the points of agreement between the Papuans, the Negritos, and the Australians and the African Negroes, and concluded that these and their allies formed branches of one great family. He

suggested certain changes of physical geography which would account for the necessary migrations, and pointed out the fact that to the northward the Himalayas and other natural boundaries formed a line beyond which no traces of the Melanochroic Group were met with. He then referred to the distribution of certain animals, particularly of the old-world monkeys, as supporting the view of the continuity and isolation of the region assigned to the Melanochroic races, and finally suggested that the Negroes of Africa, and the Negritos of the Southern Islands probably represented two tolerably pure developments of the group, while he supposed that the Australians had been influenced both in language, and to some extent in blood, by contact with the Malays.

To the Leucochroic Group were referred the Aino of Yesso, certain white races inhabiting the neighbourhood of the Amour in Eastern China, and other Chinese races, as well as the ordinarily accepted Caucasian nations. The author suggested that the great central plateau of Asia had probably been the original seat of the Leucochroic peoples, whence they had spread westward as far as the British Isles. He described briefly the natural boundaries of the region under consideration, and pointed to the distribution of certain animals, and particularly of the true wolves, as indicating a natural continuity of the region.

The recognized Mongol, the American Indian, the Eskimo, and their allies, were regarded as forming the Mesochroic group; but the writer also suggested that there was strong evidence in favour of including the Basks of Western Europe in this group, and drew attention to the curious affinity which had been traced between the Basks and certain mixed races of North Africa. No opinion was hazarded as to the original seat of the Mesochroic group of peoples, but they were supposed at one time to have occupied the whole of America, and to have had in

Europe and Asia an extension corresponding to that of the extinct Rhinoceros, while the agreements between the Bask and the North American Indian, and the existence of the Rhinoceros in America, east of the Rocky Mountains, was regarded as evidence (though perhaps insufficient evidence) of the former existence of the much-disputed Atlantis.

Reports of Meetings.

GENERAL.

THE Society's meetings during the past Session have been regularly held on the first Thursday in the month. At the meeting in October some alterations and additions to the bye-laws, passed at the annual meeting held on May 3rd, 1883, were confirmed. And a paper was read by Professor W. J. Sollas, on "Dousing or Divining for Water," which produced a lively discussion. This will be found printed in full on another page.

In November, Mr. Thos. Morgans, C.E., gave an interesting account of the industry of wood distilling as practised in England. At the end of his paper Mr. Morgans exhibited a specimen of iron pipe which by long immersion in the liquors from wood distilling had lost much of its iron and become soft like graphite, and had acquired the power of marking paper.

In December, Professor Ramsay and Dr. Young gave, in their lecture-room at University College, to an unusually large gathering, a paper on "Ice, Water, and Steam," in which they gave some account of their recent important investigations in physical chemistry.

Dr. S. P. Thompson read, at the January, 1884, meeting, a paper on "Crimson Sunsets," which attracted much interest.

At the meeting in February Mr. Shenstone gave an account of some experiments made by Dr. Tilden and himself on the solubilities of salts at high temperatures, and suggested a physical theory of solubility based upon the present known facts relating to this subject.

On March 6th, Mr. Jupp read a paper on "Observations of Climate."

On April 3rd, Professor S. P. Thompson read a paper on "Recent Researches on Dynamo-Electric Generators."

On May 1st, Mr. James Dallas read a paper on "The Primary Divisions and Geographical Distribution of Mankind."

Abstracts of the papers by Messrs. Jupp, Thompson, and Dallas will be found in the preceding pages.

PHYSICAL AND CHEMICAL SECTION.

THE Section has 39 members, and has met regularly according to a programme issued to the members at the beginning of the Session. Papers have been read by the following gentlemen:—Mr. H. B. Jupp, Professor Ramsay and Dr. Young, Professor H. S. Shaw, Rev. F. Smith, Mr. Shenstone, Professor S. P. Thompson, Dr. Tilden, and Mr. A. M. Worthington, and some of them have been printed in the Transactions of the Society.

A copy of Faraday's electrical researches has been presented to the Library by the Section during this Session.

W. A. SHENSTONE, *Hon. Sec.*

BOTANICAL SECTION.

THE usual programme of Saturday afternoon excursions was carried out during the summer of 1883.

Watson's Topographical Botany, ed. II., and a copy of the old series of the "Phytologist," in 5 vols., now scarce and valuable, were purchased for presentation to the Society's library.

At the annual meeting, on March 14, 1884, the hon. sec. read two papers entitled "The Life-history of *Lithospermum purpureo-cœruleum*, L.," and "The Flora of the Avon-bed." These are published in the current number of the Transactions.

J. W. WHITE, *Hon. Sec.*

GEOLOGICAL SECTION.

APRIL 12th, at the invitation of Mr. C. Richardson, an excursion was taken to the railway cutting and works of the South Wales Union Railway. The party went by train to Pilning, and thence walked through the cutting in the alluvium. Mr. Richardson called attention to some beds of peat, which appear to indicate alterations in the level of the land.

At Whitsuntide an excursion was made to Salisbury and neighbourhood. On Monday the museums were visited, and then Old Sarum and Stonehenge. On Tuesday the Valley of the Nadder was visited, and the geology explained by Professor Sollas. On Wednesday the party went to Wilton and Heytesbury, and thence returned to Bristol.

A. C. PASS, *Hon. Sec.*

ENTOMOLOGICAL SECTION.

DURING the summer of 1883 only two excursions of the Section were taken, to Glen Froom, Stapleton, and to the neighbourhood of Wotton-under-Edge. During the latter excursion a large number of species were captured, among which might be mentioned—

Boty's pandalis,
,, *lancealis,*
and *P. Phœodactylus.*

At the in-door meetings of the Section no papers of importance have been read with the exception of portions of Mr. Hudd's list of the Lepidoptera of the Bristol District, but a large number of exhibitions of rare and interesting species, both British and foreign, has been made by different members of the Section.

GEO. HARDING, *Hon. Sec.*

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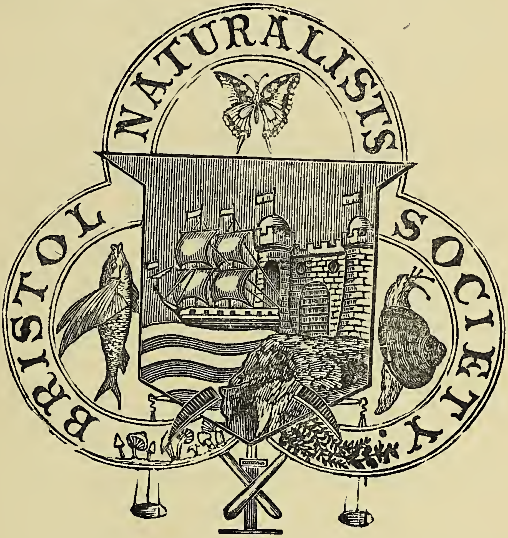
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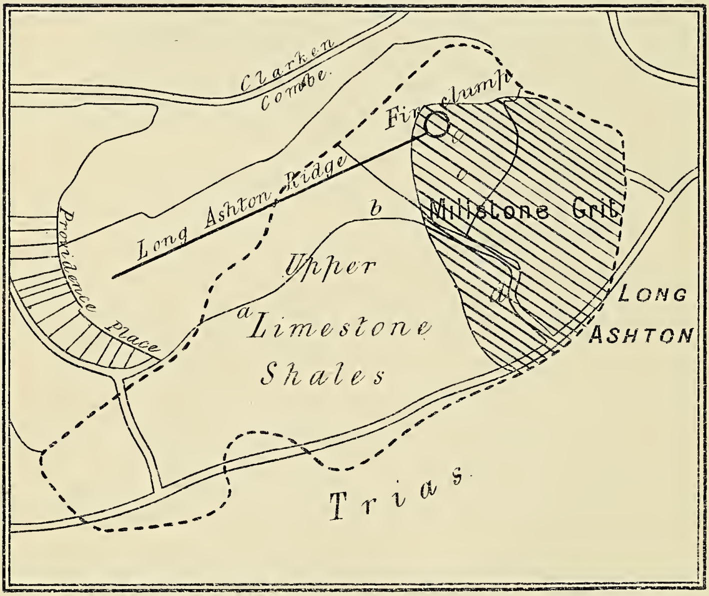

Map of the Millstone Grit near Long Ashton.

Scale - 4 Inches to 1 Mile.

On the Mapping of the Millstone Grit, at Long Ashton, near Bristol.

By Prof. C. LLOYD MORGAN, F.G.S., Assoc. R.S.M.

THE object of this note is to correct an error in the mapping of the Millstone Grit on the hill above the village of Long Ashton.

The dotted line on the accompanying map shows Mr. Sanders' boundary of the Grit, followed by the Geological Survey. The area diagonally shaded shows the limits of the Millstone Grit according to my own observations.*

That which Mr. Sanders took to be the northern and eastern boundary of the Grit I hold to be a band of reddish Sandstone in the Upper Limestone Shales, which crops up somewhat boldly at the surface. The beds which immediately overlie it have been recently rendered visible in a section exposed during the formation of a cricket-field by Mr. Kemp, the Head Master of Long Ashton School. The section is in parts confused, owing to its superficial nature. The following is, however, my reading of it :—

---

* I first visited Long Ashton Ridge with my friend, Mr. James Dallas, F.L.S., then Curator of the Bristol Museum, and had, for awhile, the advantage of his advice and assistance. Since his appointment to the Curatorship of the Exeter Museum, I have been forced to continue the observations alone. And for the conclusions reached I am alone responsible.

	FEET.
Brownish sandy beds	6
White close Sandstone	1
Yellow and brownish-red sandy Marl, with white-Clay-Marl bands	8
Purple Marl	4
Hard Limestone	6½
Friable yellow-red Sandstone	4½
Close-grained hard Sandstone	2½
Purple Clay Marl	24
Limestone, massive, and highly ferruginous in parts ...	18
Silicious Shale with black ferruginous bands... ...	6½
Solid Limestone	8
	89

The position of this cricket-field section is marked *a* on the map. The beds clearly belong not to the Millstone Grit but to the Upper Limestone Shales.

At the point marked *b* are several old quarries in which a hard purple limestone has been worked. I take it that these limestone beds, which I estimate at 20 or 25 feet in thickness, overlie somewhat closely the top beds of the cricket-field section, and there are indications of a sandstone bed in turn overlying them.

At the point marked *c* on the map Millstone Grit has been largely quarried. The beds dip at an angle of 23½°.

From the lowest grit exposed, the sandstone bed which marks Mr. Sanders' boundary is distant about 125 paces in a horizontal line at right angles to the strike of the beds. This would give a thickness of say 143 feet, of which, as we have seen, 89 feet are displayed in the cricket-field section at *a*, and say 21 feet at *b*; this leaves 33 feet in which the Upper Limestone Shales may shade into the overlying Millstone Grit.

At the point marked *d* in the map grit is exposed in the banks of the lane.

In considering the map it must be remembered that the firm line marks the axis of the ridge, from which the ground dips somewhat steeply in all directions. The marked south-west expansion of the area of the Upper Limestone Shales under consideration (*i. e.*, between the dotted line of the sandstone band and the area of the Millstone Grit) is due to the fact that the beds here are dipping with the hill.

Note on the Total Eclipse of the Moon,

4 OCTOBER, 1884.

By GEORGE F. BURDER, M.D.

A TOTAL eclipse of the moon, although less attractive to astronomers than a total eclipse of the sun, is not without features of interest, and the recent eclipse was rendered especially remarkable by the occurrence of a circumstance, which, although noted by old observers, had perhaps not been previously witnessed by any one now living. I refer to the almost total extinction of our satellite as an object visible to the naked eye.

As a rule, under favourable circumstances of weather and altitude, the moon remains a striking object in the sky even in the middle of total eclipse, appearing of a dull red or coppery hue. Thus, to cite two examples only, I find recorded in my notes of the total eclipse of 27 February, 1877, that "throughout the total phase the moon was quite a conspicuous object, shining with a dull red light"; and, again, of the total eclipse of 23 August in the same year, I wrote that "the moon, even in the middle of the total phase, was a conspicuous object in the sky, and the ruddy colour was well marked."

In the late eclipse the weather and other circumstances were singularly favourable for observation; yet for some time before and after the middle of totality nothing was visible of the moon beyond a faint dingy-brown nebulous spot, to which it was impossible to assign any definite form or dimensions. From the window of a room in which lights were burning it could not be seen at all, and in the open air many persons failed to discover it. With an opera glass the nebulous spot was resolved into a well-defined disc of the proper form and dimensions, but still very faint and dingy.

That this unusual obscurity of the moon is not to be explained by the central character of the eclipse and consequent deep immersion of the moon in the earth's shadow, will clearly appear when it is stated that in the eclipse of August, 1877, above referred to, the immersion of the moon in the earth's shadow was still deeper than on the late occasion ; and, further, that in the recent eclipse the unusual obscurity of the eclipsed portion was such as to attract notice even before the immersion was complete—indeed it was not until within a few minutes of totality that the dark part of the moon could be distinguished with the naked eye.

A consideration of the causes of these great differences in the visibility of the eclipsed moon raises of necessity the previous question of the reason why the eclipsed moon is visible at all ; and it is chiefly because there appear to me to be reasons for doubting the correctness of the views commonly accepted on this matter that this note is offered.

The following quotation from a newspaper article published in anticipation of the late eclipse may be taken as representing the current opinion :—

> "Even after the immersion in the shadow some of the rays of the sun's light are reflected through our atmosphere on the lunar surface, just as we receive the rays after the sun has really descended below our horizon. . . . . The explanation of the visibility or the partial or total disappearance was first satisfactorily given by Kepler, who showed that if the part of the terrestrial atmosphere through which the solar rays pass be tolerably free from vapour, the red rays are almost entirely absorbed, leaving the blue rays, which give too feeble an illumination to render the moon

visible; while, on the other hand, if the atmosphere be highly saturated, the blue rays are more effectually absorbed, and the red rays transmitted to the moon, thus rendering it visible. The parts of the atmosphere through which the rays pass are sometimes saturated to different extents; hence some parts of the disc are seen better illuminated than others."

To take the last part of this quotation first, it may be well to explain that the main differences in the illumination of the different parts of the eclipsed moon are undoubtedly due to the position of the moon in the earth's shadow. The portions of the moon's disc nearest the edge of the shadow are the brightest, those most deeply immersed are the darkest. Hence in the first part of the total phase the preceding or eastern portion of the disc is the darker, the following or western portion is the brighter; while in the latter part of the total phase the reverse obtains. In the middle of the total phase, if the moon pass above the centre of the shadow, the upper portion will be the brighter; if it pass below the centre, the lower portion will be the brighter. If the eclipse be nearly central, then in the middle of totality the central parts of the moon's disc will be somewhat darker than the surrounding parts. These are the appearances which should on theory be observed if the source of illumination is tolerably uniform around the earth's circumference, and according to my own observations they are the appearances which are actually observed with little or no variation. The intrinsic differences in the brightness of the different parts of the moon's surface—differences familiar to everybody—must of course be also taken into account. I doubt if there is sufficient evidence of inequalities of illumination of the different parts of the moon's disc beyond what may be referred to one or other of these explanations.

Passing to the more essential part of the theory stated in the foregoing extract, its inadequacy may, I think, be shown by the following considerations.

The portion of the earth's atmosphere through which the solar rays will pass to reach the moon will clearly be an entire ring, embracing almost all varieties of terrestrial climate. It is inconceivable that there should be anything approaching to uniformity in the hygrometric condition of this atmospheric ring. It is almost equally inconceivable that there should be any very large diversity in the *average* hygrometric condition of the whole ring at any two epochs. But in order to account for the observed results, both of these improbable hypotheses must be assumed. For, in the first place, if there were not an approach to uniformity throughout the ring on any given occasion, the variations due to the position of the moon in the shadow (as explained above) would be in a great measure masked, which, as a rule, they certainly are not; and, in the second place, if there were not a very large diversity in the *average* condition of the whole ring at two epochs, there would be no explanation of the phenomenon now under discussion. It cannot be that the large hygrometric differences which we know to exist between the tropical and the arctic regions should have an effect scarcely if at all appreciable, and that the small differences which are all that we can imagine possible between the average condition of the whole atmospheric ring at one time, and its average condition at another time, should suffice to explain the difference between conspicuous visibility at one time and absolute disappearance at another time.

The suggestion of the *solar corona* as the source of the light which illuminates the eclipsed moon seems so obvious that I cannot suppose that it has not occurred to others besides myself. But, so far as I know, it has not hitherto been published, and certainly it has not been generally accepted. To my mind it fulfils all the conditions required. Whatever the real nature of the corona may be, no doubt remains of its existence as an actual luminous body surrounding the sun. From the degree to which its light mitigates the darkness on the earth in a total eclipse of the sun, we may form an estimate of the degree to which it will illuminate the moon in that which is to the moon a total eclipse of the sun. It is true the illumination will not be equal in the two cases, because the earth, being very much larger than the moon, will intercept to the moon a very much larger portion of the corona than the moon can intercept to us, and the portion so intercepted will include all the more central and brighter parts; still, even so, enough may remain, and it must be remembered that the fainter parts of the corona probably extend very far beyond what has been actually seen. Whether the amount of light given out by the corona varies greatly at different times, may not be easy to prove, but at least it may be said that the inconstancy of form and general appearance which the corona has exhibited in different eclipses, renders such variation probable. This being admitted, we have only further to assume that in the rare instances in which the eclipsed moon becomes invisible, the light of the solar corona is at its minimum, and the explanation is complete. Possibly, in course of time, with improved methods of investigation, this coincidence of the two phenomena, at present a speculation, may become an observed fact.

Sub-aerial Denudation and the Avon Gorge.

By Prof. C. LLOYD MORGAN, F.G.S., Assoc. R.S.M.

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1.—*Introduction.*

WHEN the Geological Section of this Society did me the honour of inviting me to be their president, I bethought me in what way I could best fulfil what seemed to me one of the most important duties of that position. For it is, I take it, the primary function of such a Society as ours, to investigate and elucidate the Natural History—using these words in their widest signification—of our own immediate neighbourhood. And it should therefore be the object of the president of the Geological Section, to endeavour to add something to our knowledge of the geology of our district, and to indicate to his brethren of the hammer what seem to be the most promising fields of research.

Now there is one branch of Geology that has always had for me a special charm, probably through the influence of my esteemed master, Sir A. C. Ramsay, and that is the dependence of scenery on geological structure. And it so happens that this point is admirably exemplified in many parts of our own district. It seemed to me therefore, that it would be worth while trying to work out this subject in some detail for the country in the neighbourhood of Bristol. For I felt that assuredly there is nothing like such detailed examination for proving or disproving the truth of those principles of Denudation which are now so generally accepted among geologists. Such work would moreover afford opportunities of verifying that most admirable map which Mr. Wm. Sanders has bequeathed to us—a piece of work of which Bristol may well be proud. The task I set myself, then, was the investigation, in some detail, of the influence of geological structure on the scenery of the Avon basin, and at the same time the verification of the recognized geological map of the district. But the subject is a large one, and I hereby call upon the members of the Bristol Naturalists' Society in general, and upon those of the Geological Section in particular, to co-operate with me in this work.

In this paper I propose to deal with the Sub-aerial Denudation of that section of the Avon Basin which lies between Bristol and the Channel. But first I must say somewhat by way of introduction.

The errors of geologists of the past are apt to live on in the popular notions of to-day. Two such cardinal errors there are in connection with my present subject. They may be termed the Diluvial error and the Volcanic error. Looking out on the diversified surface of the land, and impressed with the grandeur of its physical features, men, so soon as they began to admit the possibility of such features being caused at all, searched throughout nature for causes sufficiently potent to produce the high ridges, the broad valleys, and the deep ravines which they saw around them. One cause alone seemed of sufficient power to raise the land into ridges many miles in length and a thousand feet or more in height. And that cause was fire (so-called), with whose work they were well acquainted in volcanic outbursts of great magnitude. It seemed, moreover, to be obvious that the same volcanic force which upheaved the hilly ridge would also tear through its midst huge rents and chasms. Speaking, for example, of the Mendips, Dean Buckland said in 1849, in his presidential address at the first annual meeting of the Somersetshire Archæological Society, "If we ask the cause of the extensive elevation of a chain of hills, 20 miles long, and from 3 to 6 miles wide, and from 200 to more than 800 feet in height, we must refer it to the same uplifting and explosive force of vapours generated within the earth by the subterraneous fires, which are still producing earthquakes and exploding ashes and streams of lava in regions which are at this time agitated by nearly 200 burning volcanoes on the actual surface of the globe. Fractures and dislocations which attended the elevation of these strata from the bottom of the sea may be seen in the rocks at Cheddar Cliffs, on the east flank of Mendip; and in the yawning chasms of Brockley Combe and Goblin Combe, on the west side of Broadfield Down, near Bristol; and in the gorge through which the Avon passes at Clifton." (*Proceedings*, 1849-50, p. 17.)

Thus did Dean Buckland, who may be taken as the representative of a bygone age of Geology, account for the upheaval of such ridges as we find in our neighbourhood, and at the same time for such deep ravines as the Clifton Gorge. And how did the Dean account for those wider and more open valleys, in the formation of which volcanic force would seemed to have played no part? Here, again, there would seem to be but one agent of power sufficiently magnificent to produce these physical features—the mighty ocean. Such a valley, writes the Dean (*Trans. Geol. Soc.*, ser. ii., vol. 1, p. 96), "must be referred exclusively to the removal of the substance that once filled it; and the cause of that removal appears to have been a violent and transient inundation. . . . The diluvian waters to which these effects must be referred (if we except the very limited and partial action of modern causes, such as of torrents in cutting ravines, of rivers in forming deltas, of the sea in eroding its cliffs, and of volcanoes in ejecting and accumulating their exuviæ) appear to have been the last agents that have operated in any extensive degree to change the form of the earth's surface."

Vulcan and Neptune, then, shared the honour of preparing for us the scenic beauty of the earth's surface. Opinions differed as to the question to which deity we were most indebted for the production of our scenery. But no doubt the majority sided with old Buffon, who thus concludes the first book of his Natural History: — "From all these observations we may fairly conclude," he says, "that it is the continual motion of the flux and reflux of the sea which has produced mountains, valleys, and other inequalities on the surface of the earth; that it is the currents of the ocean which have hollowed valleys, raised hills, and given them corresponding directions; that it is those waters of the sea which by transporting earth, &c., and depositing them in horizontal layers, have formed the parallel strata; that it is the waters from heaven which by degrees destroy the effects of the sea, by continually lowering the summits of mountains, filling up valleys, and stopping the mouths of gulfs and rivers, and which, by bringing all to a level, will, in the course of time, return this earth to the sea, which, by its natural operations, will again form new continents, containing valleys and mountains exactly similar to those which we at present inhabit." (*Barr's Translation,* vol. i., pp. 67, 68.) For such heresies as these was Buffon invited by the Sorbonne to publish a formal recantation, wherein he said, "I abandon everything in my book respecting the formation of the earth." And modern Geology is for once in accord with the Church in deeming heretical such views as these, curious inversions as they are of modern geological doctrine.

For as determinants of the scenery of such a district as ours, neither Vulcanism nor Neptunism can supply a *vera causa.* Among geologists the Volcanic error and the Diluvial error are well-nigh things of the past. They are forced to shun the light and lurk in that shadowy land that is tenanted by popular notions. The geologist of to-day believes that such ridges as border or intersect the Avon Basin are the result, not of "the uplifting and explosive force of vapours, generated within the earth by subterranean fires," but of intense lateral pressure, by which the strata were thrown into folds, just as a number of pieces of cloth, placed one upon another, will be thrown into folds if pressed from side to side. In proof of which he points to the fact that if you, in imagination, straighten out the strata folds, they will occupy a longer arc of the earth's surface than they do now after the lateral compression. The rocks are not blown out as a bubble, and so put on a stretch, they are compressed into a shorter space; just as are the layers of cloth when they are pressed from side to side. And this lateral pressure, which would seem to be definitely connected with the secular cooling of the earth, has acted, in our district, in the main in a N. and S. direction, and has thrown the strata into folds having a general E. and W. trend.

But the ridges that we see are but small fragments of the bold curves which were produced by this intense lateral pressure of a long-ago age—a pressure that would seem to have set in in post-Carboniferous, pre-Permian times. By lateral pressure, indeed, were the strata *raised,* but by sub-aerial denudation they have been *carved.* The deep ravines and the broad valleys are alike the work of processes of earth-sculpture, effected in the main by rain and rivers. The vast amount of detritus carried down to the sea by rivers—detritus which has contributed largely to the formation of the sand and mud-banks of the Severn estuary—is the waste matter removed during the process of sculpture, and adds not a little to the weight of other evidence in favour of the hypothesis of sub-aerial denudation. In a word, just as Fire and Diluvium were the watchwords of the physical geologists of a past generation, so is Denudation the watchword of the physical geologist of to-day.

2.—*Sub-aerial Denudation, general and special.*

The agents of sub-aerial denudation may conveniently be divided into two classes; first, those which exert their influence over the general surface of the country, such as rain, frost, and that more extended action which is known as weathering; secondly, those which exert their influence along special lines or over special areas, such as rivers and streams and glaciers. We may call the work done by the first class of agents, *general denudation*, and that done by the second class of agents, *special denudation.* And we may say that the vertical contouring of the country—with which alone we are here dealing—is due to the *differential action of general and special denudation on rocks of different powers of resistance.*

The action of general denudation may be likened to the action of sandpaper; that of special denudation to the action of a file. If we take one of those not uncommon slabs of slate rock, through the midst of which there runs a band of much harder quartzite, and, choosing a flat surface, apply our file to this, keeping its cutting edge parallel to the surface, we shall cut a deep notch-like groove in the slab. The groove will be of equal depth in the soft slate and in the hard quartzite; for the depth to which the file can cut into the mass as a whole, is limited by the depth to which it can cut into the hardest band. Now, laying aside our file, let us apply our sandpaper. After scouring vigorously for a short time, we shall find that, in the softer slate, the material has been worn away on either side of the groove to such an extent that the groove has become a wide depression, with sides very gently sloping down to that which was the bottom of the notch-like groove. But in the quartzite band the case is different. Here the sandpaper has less effect. The groove is scarcely or not at all widened. The quartzite band, moreover, stands out as a ridge across our slate; for the sandpaper has worn away the softer slate on either side of the harder band.

Now let us see how far this illustration serves to aid us in the comprehension of the action of general and special denudation on a large scale. The action of a river is like the action of our file; it cuts a deep notch, gorge, or ravine. It is true that the river-file has some *lateral* play; for streams not only cut downwards but also eat into their banks and thus cut sideways. And they do this the more the softer the strata through which they flow. Still this only somewhat widens the groove. And it remains true that the office of rivers is to cut deep trenches into the surface of the land. They are the agents of denudation along special lines. And just as the file is unable to cut deeper into the softer slate than into the harder quartzite, so is a river unable to cut deeper into softer than into harder rocks—that is, so long as the softer rocks lie further up stream than the harder rocks. A band of hard rock, in fact, limits the depth to which a river can cut its way down into all the strata which lie further up stream, no matter how soft they may be.

The action of rain, frost, and the weather, on the other hand, is like the action of the sandpaper in our experimental illustration. The action is general over the entire surface; not special along definite lines. It wastes away the surface over the area of the softer strata ; but having less effect on rocks of greater resisting power, leaves them to stand out as bold ridges. Its action, moreover, is not limited in any way by the depth to which it can waste the harder bands. That which limits the depth of its action is the level of the river into which the detritus, which results from the general waste, is carried. For unless the detritus be removed, further waste is impossible. And thus we come to see that a band of hard rock, in limiting the depth to which a river can cut its way down into the rocks which lie further up stream, determines at the same time the level to which general denudation can reduce the whole surface of the land which lies up stream.

3.—*The Physical Features of the Area under consideration.*

The physical features of the area under consideration *(see map)* are in some respects remarkable. The Avon which has, above Bristol, emerged from a woody gorge, passes, near Bristol, through more open country, extending right and left from either bank, and then, below Bristol, makes its way between the steep slopes, and, in places, precipitous rock faces of the Clifton Gorge, emerging thence into more open country ere it finally passes through a band of Severn flats into the Bristol Channel. Opening out into the main ravine are several lateral valleys or gullies, some of them having now dry beds, others occupied by brooks or " pills."

A bird's-eye view of this part of the country will show on the Somersetshire side of the Avon a well-marked ridge of Downs, trending to the S.W. On the Gloucestershire side the ridge is split into two portions, of which one soon ends off, as the tongue-shaped Clifton Down, while the other, somewhat further north, passes N.E. as Durdham Down, and then making a bold curve round Westbury, passes W. and a little S., along Henbury Down and King's Weston Down, to end off at Penpole Point. Between Henbury Down and King's Weston Down the ridge is deeply notched at Coomb Dingle, and through the notch runs the Henbury branch of the Trym. Within this horse-shoe ridge of Downs lies the lower, but never very low, land, through which the Trym makes its way to the Avon.

On the Somersetshire side of the Avon there runs, at the foot of the more southerly slope of the Downs, a broken and discontinuous ridge, marked by tumps and wooded clumps, and continued, on the Gloucestershire side, by Brandon Hill and the ridge on which the University College stands. North of the ridge of Downs, on the other hand, runs a line of depression, the collecting ground of several streamlets, tributaries of the Avon. North of this, again, is a well-marked ridge curving round from Failands House through Abbot's Leigh; through this ridge the tributary streams cut deep notches. North of this once more is another somewhat discontinuous line of depression, where the tributary streams themselves receive minor tributaries. Finally, to the north of this is irregularly rising ground, through which the tributaries cut notch-like valleys to the Avon.

Such, in brief, are the physical features of the area. Let us now see how far this physical configuration is dependent upon geological structure.

4.—*The Geological Structure of the area under consideration.*

The rocks in our area may be divided into two series, an older and a newer; whereof the newer lie more or less horizontally on the upturned edges of the older, and occupy the depressions which resulted from a very ancient denudation.

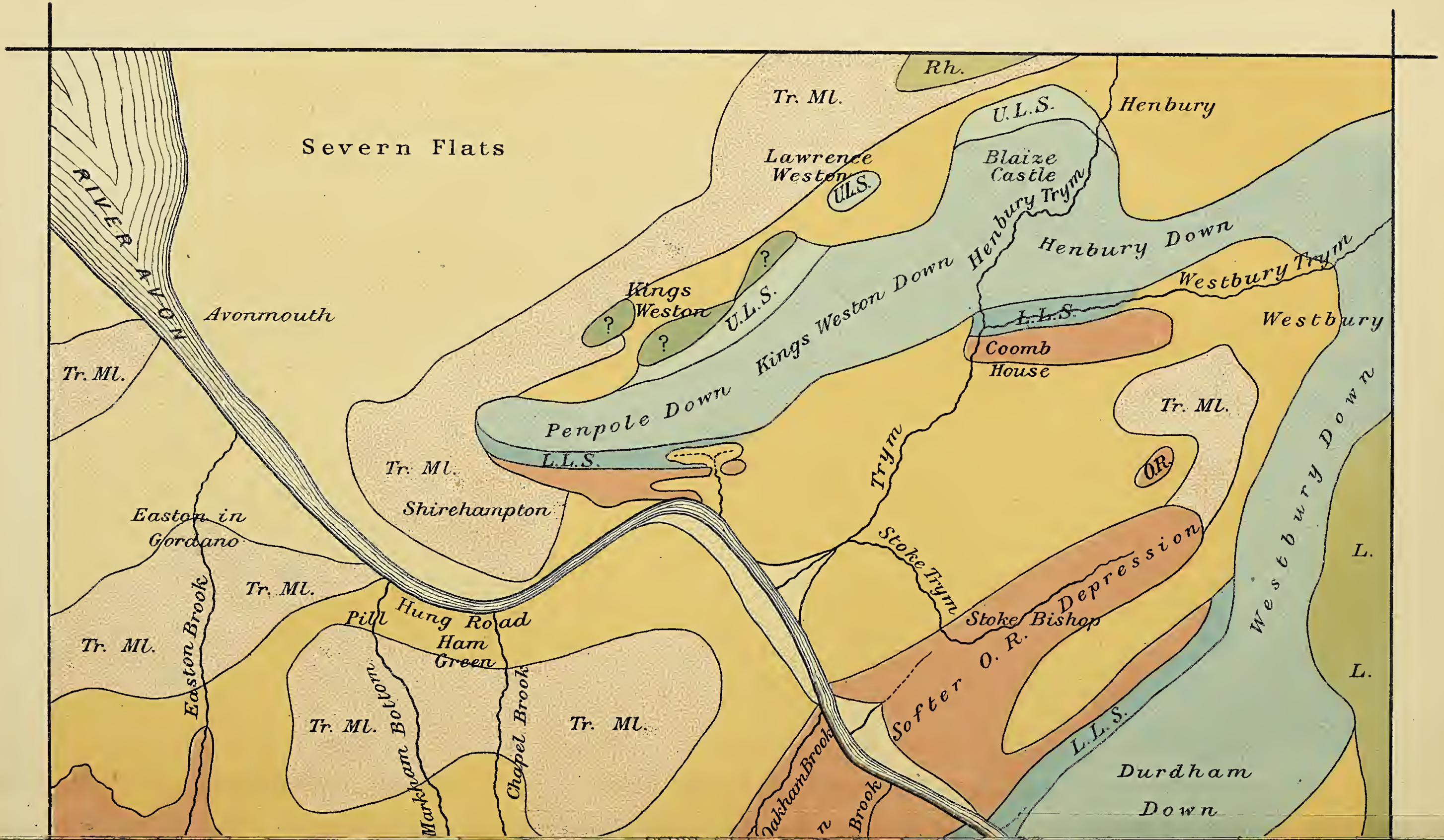
To begin with the older series. The broken ridge, of which

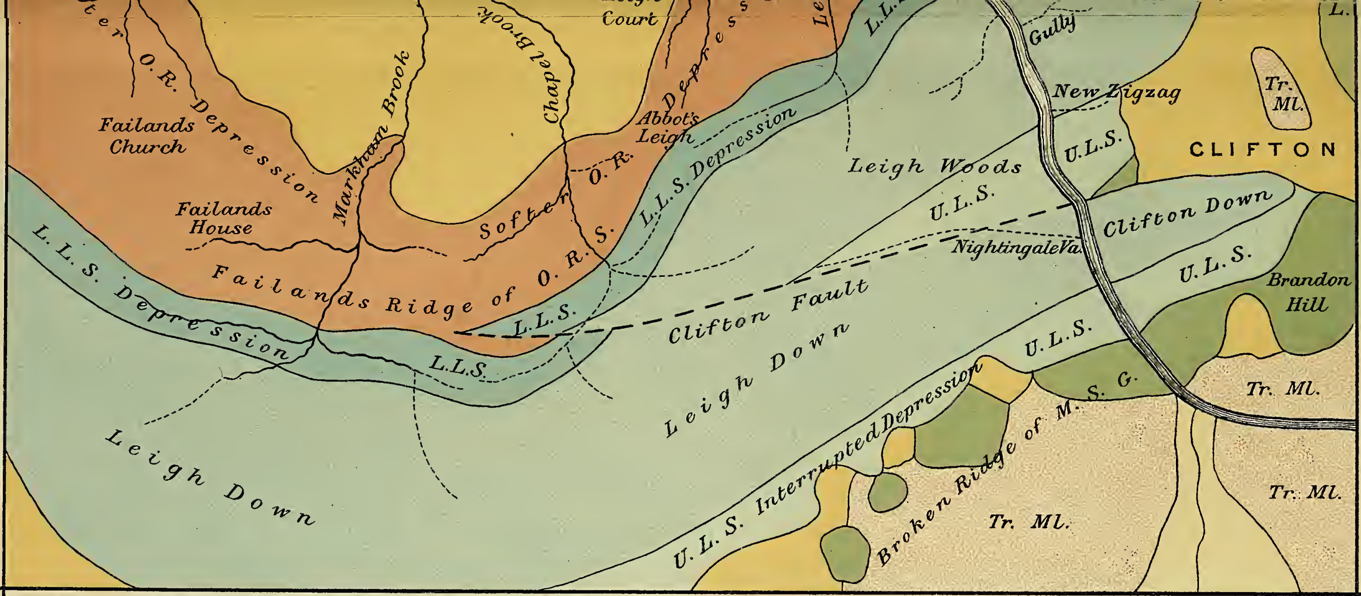
Brandon Hill forms a part, is composed of hard Millstone Grit, dipping to the S.E. at an angle of some 25°. That is followed by the softer Upper Limestone Shales, which form the southern slope of the Downs, and give rise to hollows or depressions, generally filled up with the rocks of the newer series. The whole ridge of the Downs, from Leigh Down, through Durdham Down, Westbury Down, Henbury Down, King's Weston Down, to Penpole Point, is formed of massive Mountain Limestone. How it comes that Clifton Down is separated from Durdham Down, we shall see presently. The depression to the N. of Leigh Down is occupied by softer Lower Limestone Shales. The Failands ridge, to the N. of this depression is composed of the upper and harder conglomeratic beds of the Old Red Sandstone. And the discontinuous depression yet further N. is occupied by the lower and softer beds of the same group of Old Red rocks: the discontinuity being partly due to overlying newer beds. The same soft Old Red rocks also occupy the depression just W. of Stoke Bishop, on the Gloucester side of the Avon *(see map)*.

On the inner side of what may be termed the Westbury horseshoe, the Lower Limestone Shales form a discontinuous band —the discontinuity being due to the presence of overlying strata of more recent age. Beneath these beds the Lower Limestone Shales are without doubt continuous. Inside this band, again, is the band of harder Old Red Sandstone, which, E. of Shirehampton, N.E. of Cook's Folly, and again at Coomb House, rises out of the mantle of newer rocks which elsewhere hides it from our view. The lower and softer beds of the Old Red Sandstone probably occupy the rest of the area within the horseshoe. But they are almost entirely covered up by the newer secondary rocks.

The central axis of the horseshoe forms an anticlinal axis, from which the King's Weston and Henbury beds dip down

PLATE II


Rh.
Tr. Ml.
Henbury
U.L.S.
Severn Flats
Lawrence Weston
U.L.S.
Blaize Castle
Henbury Trym
Henbury Down
Westbury Trym
Kings Weston
?
?
?
U.L.S.
Kings Weston Down
L.L.S.
Coomb House
Westbury
RIVER AVON
Avonmouth
Tr. Ml.
Penpole Down
Tr. Ml.
L.L.S.
Trym
O.R.
Westbury Down
L.
L.
Tr. Ml.
Shirehampton
Easton in Gordano
Stoke Trym
Stoke Bishop
Depression
Softer O. R.
Tr. Ml.
Pill
Hung Road
Ham Green
Tr. Ml.
Easton Brook
Tr. Ml.
Markham Bottom
Chapel Brook
Tr. Ml.
Oakham Brook
n Brook
L.L.S.
Durdham Down



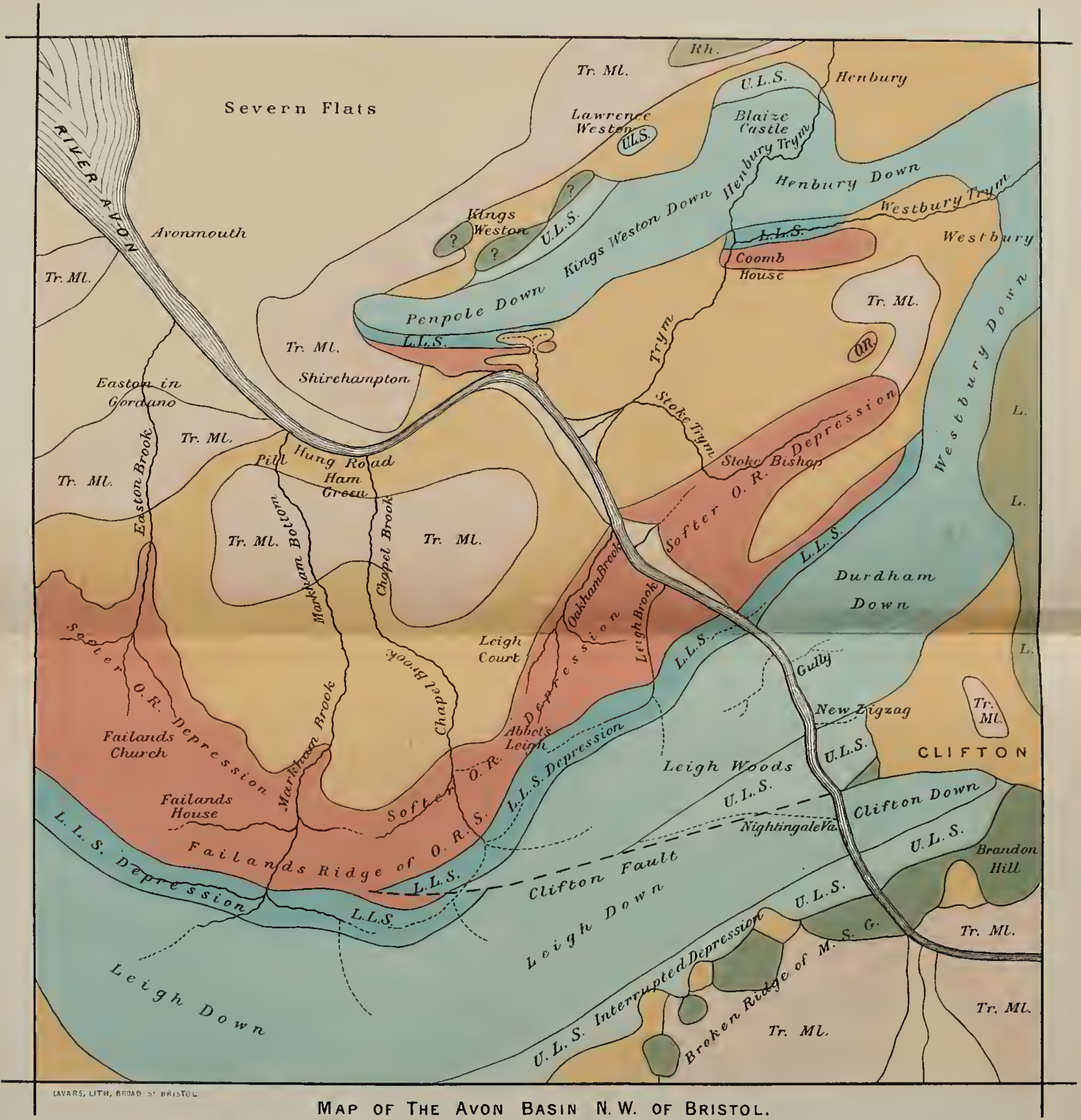
LAVARS, LITH, BROAD ST BRISTOL.

MAP OF THE AVON BASIN N.W. OF BRISTOL.

▨	*Old Red Sandstone.*	▨	*Dolomitic Conglomerate.*
L.L.S.	*Lower Limestone Shales.*	Tr.Ml.	*Trias Marls.*
▨	*Mountain or Carboniferous Limestone.*	Rh.	*Rhœtic.*
U.L.S.	*Upper Limestone Shales.*	L.	*Lias.*
▨	*Millstone Grit.*	☐	*Alluvium.*

SCALE, 1·5 INCH TO 1 MILE.

PLATE II



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U.L.S.	*Upper Limestone Shales.*	L.	*Lias.*
🟩	*Millstone Grit.*	⬜	*Alluvium.*

SCALE, 1·5 INCH TO 1 MILE.

towards the N.W., while the Clifton and Durdham rocks dip down towards the S.E. There is, however, a roll in the strata which gives rise to a minor anticlinal, the axis of which is parallel to the Henbury Down, and runs a little to the N. of Coomb House, causing the beds of Old Red and Lower Limestone Shales, which are exposed near the junction of the Henbury and Westbury Trym, to dip to the S.E. Were the Mountain Limestone beds, the Lower Limestone Shales, and the upper Old Red beds, in each case, continuous over the main anticlinal, they would form a dome-shaped arch over the whole of the Westbury horseshoe. The upper part of the dome has, however, been entirely removed by denudation, so that only the spring of the arch has been left on either side.

Turning now from the Palæozoic rocks to the newer or Mesozoic beds which lie on their upturned edges, it will be sufficient for my present purpose to notice, first, the so-called Dolomitic Conglomerate, which immediately covers the older rocks over the greater part of the area where the Mesozoic beds occur. This Dolomitic Conglomerate is composed of larger or smaller fragments of the Palæozoic rocks, cemented together by a reddish or yellowish paste. The whole forms a mass of considerable hardness and resisting power. On its surface rests the newer red Keuper Marls; and here and there, above this again, we find the Rhœtic beds, and the yet more recent Lias.

The Dolomitic Conglomerate occupies the dip between the Clifton and the Durdham Downs, and may be seen in the New Road, near Proctor's fountain, resting upon the upturned edges of the Mountain Limestone. It occupies the greater part of the area enclosed within the Westbury horseshoe, and is found again fringing the northern side of the Henbury and King's Weston Downs. It forms on the Somersetshire side of the Avon the rising ground that lies to the north of the softer Old Red depression, and is found in patches on the southern flanks of the Leigh Down limestone ridge.

Overlying the Dolomitic Conglomerate in larger or smaller patches are the Keuper Marls, as at Pill and to the S.W. of Westbury; and they form the low-lying band from Easton-in-Gordano through Shirehampton, King's Weston, and Lawrence Weston. This band dips gently down beneath the yet more low-lying fringe of Severn flats.

Overlying this again, N. of Blaize Castle, is a small patch of Rhœtic; while the Lower Lias Clay rests directly on Mountain Limestone in the area to the E. of Westbury.

A comparison of this section with the last, and a reference to the map, will show how clearly the general physical features of the area are determined by the general geological structure. So that the geological colouring in our map at once indicates the nature of the physical contours; while, *vice versa*, contouring would at once indicate geological structure.

5.—*The Age of the Rocks at King's Weston.*

In the map I have in the main followed Mr. Sanders and the Geological Survey. There are, however, one or two points in which I have made some slight alterations; and of some of these I would now say a few words.

In the first place, I have given a separate colouring to the Upper Limestone Shales, chiefly because the effects of the Clifton Fault thereby become more obvious. The line of division between these beds and the Mountain Limestone is, however, approximate.

Secondly, I have introduced a slight alteration where the Westbury Trym, after passing through the notch in the Mountain Limestone, passes out into the Dolomitic Conglomerate. Both Mr. Sanders and the Survey, map the Mountain Limestone in contact with Old Red at this point, without any intervening Lower Limestone Shales. Such a state of things is impossible without a fault. And I can find no evidence of a fault or of this contact of Mountain Limestone and Old Red. I have therefore in the map substituted my own interpretation of the facts at this spot.

Thirdly, I have suggested a somewhat important alteration in the neighbourhood of King's Weston. There are two little patches of rock there, one of which is marked in Sanders' map, and by the Survey, as Old Red Sandstone, and the other as Mountain Limestone. With regard to the latter, there can be no doubt that of whatever age it may be it is not limestone. It is sandstone of some kind. With regard to the former, if it be Old Red Sandstone it is in a very puzzling position. If there be no fault, and none is marked on the Survey map, we must suppose that the Old Red Sandstone of the limestone ridge dips down under the ridge and then emerges on its N. side at King's Weston. This, though possible, is not, I think, even in a slight degree probable. For if we look at the Survey, section No. 14, or the section given in fig. 4 of De la Beche's Memoir, which passes through Blaize Castle, we shall see that the ridge of limestone is there regarded, and I am sure rightly regarded, as an anticlinal; and it is difficult to believe that this steep anticlinal is converted into a deep synclinal at a distance of a mile or less. I have found evidences of what seem to me to be the Upper Limestone Shales in the Blaize Castle woods, and at Lawrence Weston. And I think myself that it is very probable that the King's Weston beds will prove to be Millstone Grit, or those red sandy beds which occur in the Upper Limestone Shales near their junction with the Millstone Grit. The absence of conglomeratic bands and of friable red sandstone seems to distinguish these beds from those of the Old Red series. At the same time the beds are in places micaceous, a character which marks the Old Red. I have not yet worked out the point quite to my satisfaction, nor in the absence of organic remains is it easy to come to a decided conclusion. I have therefore placed a ? on these patches of rock. And I bring this subject in this immature state before the Society, partly because, coming as it does within the area of my map, I could hardly pass it over without mention, and partly because it is one that seems to be worthy of the attention of the Members of the Geological Section. For if my views should prove to be correct, then coal under the Severn flats is a possible and not uninteresting corollary.

6.—*The Avon Gorge.*

"The vulgar notion respecting the Avon and its Gorge," writes Sir Andrew Ramsay, "is, that before the ravine was formed all the low ground through which the river and its tributaries flow was a large lake, that 'a convulsion of nature' suddenly rent the rocks asunder and formed the gorge through which the river afterwards flowed, and so drained the hypothetical lake."

This vulgar notion received its death blow when Professor Jukes, in 1867, showed "that the hypothesis of atmospheric erosion is applicable to the Clifton Gorge as to all similar places." This is now part of the common stock of geological knowledge. But I feel bound to draw attention to it here, partly to give unity to my subject, and partly because the truth of these views is enforced by the considerations which are to follow. I shall, however, content myself with a short quotation from Prof. Jukes; and a very few additional words of my own.

"Let the observer then," I quote from the *Geol. Mag.* of Oct., 1867, "stand on the highest point of Clifton Down and look up to the superior height of Dundry Hill, some six miles to the S., and he will see at once that the extension of the old oolitic sheet (of which the summit of Dundry is but an isolated outlier) would pass some 2 or 3 hundred feet over his head. That the Lias itself rested directly on the Palæozoic rocks is shown by the fact of sheets of it still stretching across the Carboniferous Limestone to the N.E. of Durdham Down, still resting in patches on the Backwell hills to the W. of Dundry, and on that of the Mendips in the neighbourhood of Harptree.

"The Lias then formerly reposed on the Carboniferous Limestone of Clifton Down, and the Oolite spread over that. The Severn and its tributaries flowing over this Oolitic plain of course cut channels in it. The original form of the surface was such as to turn the Avon towards the Severn instead of towards the Thames. The course it originally took it has ever since maintained, cutting down through the horizontal Mesozoic cover, and through the Palæozoic rock it found underneath, in whatever position it might lie, or whatever materials it might be composed of."

We have here, in fact, a conspicuous example of the differential action of general and special denudation. The Limestone ridge of the Downs is like the Quartzite band in our experimental illustration. It has effectually resisted that wasting action which has removed the Mesozoic cover. The Clifton Gorge is no chasm rent in the rocks. It is in no wise connected with any supposed volcanic upheaval in the Mendips or elsewhere. But it is the result of that continuous fretting of the stream over its rocky bed, which gives rise to special denudation, and which I have likened to the action of a file. Nor is this result any whit more remarkable, from a geological point of view, than the vast amount of general denudation which has removed so great a mass of Mesozoic rock from the country between Bath and Bristol.

7.—*The Clifton Fault.*

The strata of the Avon Gorge do not present an unbroken succession. On entering the gorge we have near Windsor Terrace, Millstone Grit. Then follow the Upper Limestone Shales, dipping to the S.E. or up stream at an angle of about 27°. After this comes the massive Mountain Limestone, on which the buttresses of the Suspension Bridge are built. As we walk through the gorge beneath the bridge, we pass through a considerable thickness of this rock. But just beyond the Clifton Station, there is a sudden change. Abutting against the Mountain Limestone are much contorted red grits and Limestone Shales. And if we ascend to the Observatory Hill, we pass, in a few paces, from Mountain Limestone on to Millstone Grit.

This sudden change is the result of the Clifton Fault, which crosses the Avon at this spot. By it the strata which lie to the N. of it are shifted downwards. Taking as a datum point the intersection of the line of fault and that of high-water mark, the rocks relatively shifted downwards are :—

On the Gloucester Side.

Mountain Limestone	710 feet.
Upper Limestone Shales	440 „
Total	1150 „

The total thickness of the upper Limestone Shales is 600 feet, so that above high-water mark there are some 160 feet, in vertical thickness, of these beds, which will extend to a height of some 180 feet or so above the river, and above them the Millstone Grit comes in near the top of Observatory Hill.

Since the fault cuts across the strata somewhat obliquely (namely at an angle of about 5° with the strike of the beds), lower beds of Mountain Limestone are intersected on the Leigh side than on the Clifton side. Hence the thicknesses of

Mountain Limestone, and Upper Limestone Shales, relatively shifted downwards, are not the same as on the opposite shore. They are:—

On the Somerset Side.

Mountain Limestone	...	...	770 feet.
Upper Limestone Shales	...	...	330 ,,
Total	...	...	1100 ,,

The difference of 50 feet in the total may be due to the dying out of the fault westwards, or it may be due to errors of observation. Since the total thickness of the Upper Limestone Shales is 600 feet, of which 330 are faulted down below high-water mark, there remains a thickness of 270 feet above high-water mark, which will extend to the top of the gorge in Leigh Woods. We should not expect therefore to find Millstone Grit on this side of the river. Nor have I been able, on careful search, to discover any of the characteristic beds of this rock, though several of the silicious bands of the Upper Limestone Shales—similar to those which are now being blasted in the river bed—crop out at the surface.

Now the Upper Limestone Shales, brought down to the N. of the fault, are softer than the massive Mountain Limestone which bounds them on either side. We should therefore expect, on the principles of denudation, that these softer rocks would have their physical expression in the contour of the land. And this is so. A marked depression, largely occupied with Dolomitic Conglomerate, separates Clifton Down from Durdham Down. And if we look across from Leigh Woods to the opposite side of the river we see that, between the bold bluff of Limestone of Observatory Hill, and the Limestone Cliffs of the Great Quarry, there is a wide space where the slope is more gentle. And this is the space occupied by the Upper Limestone

Shales. The new Zigzag path lies in a notch cut in the Limestone, from the point of junction at the edge of Durdham Down of the Mountain Limestone and the Upper Limestone Shales.

If, on the other hand, we look across from Observatory Hill, towards the Leigh Woods, we shall see to our left the beautifully-wooded cleft of Nightingale Valley; then follows a second face of limestone, which abuts against the Upper Limestone Shales brought down by the fault. The slope then becomes more gentle, for here we are in the softer shaley beds. The solid limestone is seen rising from the river bed near the railway tunnel; after which there are bold quarried limestone faces.

If we cross to the Somersetshire shore and ascend Nightingale Valley, we shall probably notice that, about half way up, the path becomes decidedly less steep. The valley also opens out and becomes wider. Here it is, I believe, that the fault crosses the valley. If, at this point we ascend the right (N.) side of the valley into Leigh Woods, we find the end of a vallum thrown up by the Britons in making their Leigh Woods entrenchment. And if we follow this camp vallum we find that it leads to the edge of the limestone bluff, which abuts against the Upper Limestone Shales faulted down. The vallum, in fact, marks the line of the fault.

Returning to Nightingale Valley and following it up, we find that it passes into a line of depression which forms a well-marked dip in the Abbot's Leigh Road, crosses Ashton Park and Beggar's Bush Lane, and so leads up to Hill Farm.

It is interesting to notice that the line of drainage, after following the line of the Upper Limestone Shales for awhile, deserts that line and passes down Nightingale Valley, thus cutting off a triangular wedge of limestone between the line of fault and the line of Nightingale Valley—a wedge which the Britons had only to fortify on its faulted side to convert it into an almost impregnable camp. I think this is due to a dislocation of the strata along the line of Nightingale Valley. This is seen also on the Clifton side of the river in the precipitous face of limestone which overlooks the little recess in which lies the Clifton Station. Such a dislocation, probably following a joint plane, is scarcely to be wondered at in the immediate neighbourhood of so well-marked a fault.

The question naturally arises, Can we trace the fault further W.? Between Hill Farm and the Lower Limestone Shale depression there is no evidence of its existence. Nor should we expect to find such evidence. For since the fault cuts the strata obliquely, beyond Hill Farm no Upper Limestone Shales would be faulted down to the surface; but the upper beds of Mountain Limestone would be faulted down against the lower beds of the same rock. There would be no difference in hardness of the beds to produce differential denudation. But when we reach the depression of the Lower Limestone Shales, we have, I think, evidence of the existence of the fault. There is, in this line of depression, just where the road from Hill Farm descends into it through a little notch in the Down, a wooded island of Mountain Limestone. This I believe to be part of a wedge of limestone let into the Lower Limestone Shales, just as the wedge of Upper Limestone Shales is let into the Mountain Limestone further E. And if this be so there must be a corresponding wedge of Lower Limestone Shales let into the Old Red Sandstone; of the existence of which I have some evidence, from the nature of the stones ploughed up in the fields at this spot.

Owing to the overlying cover of Mesozoic rocks it is impossible to trace the eastward extension of the fault.

8.—*The Gloucestershire Tributaries.*

Our object being to trace the influence of geological structure on the contouring of the land, we must not omit to notice even minor points which may serve to illustrate it. The gully, for example, near the Sea Wall, is in this respect of interest. It will be seen to owe its existence to a band of soft shaley beds (which might be locally termed the Middle Limestone Shales) which here occur in the Mountain Limestone. These beds being more readily denuded than the massive limestone have given origin to a line of drainage. The water which has flowed along this line of drainage has cut its way downwards, from the point of junction of the softer and harder beds on the surface of the Down, into the solid limestone. Thus the notch was *started* in the Middle Limestone Shales, but has been carried down into the underlying Mountain Limestone. A very similar gully may be seen on the other side of the river, entering the Avon a little further down stream. It is worth noting that the Middle Mountain Shales form a more gentle and more retreating slope than the harder limestone on either side. And this can be seen on both sides of the Avon. In fact this band of Middle Limestone Shales is most valuable to the geologist as completely disproving the hypothesis of a fault *along* the Avon Gorge. The beds answer point for point on either side of the river. There is no displacement—no dislocation of the beds.

The most important tributary on the Gloucester side of the Avon is the Trym, which falls into the river at Sea Mills. Close to its mouth it receives a Stoke branch. This branch rises in the softer band of Old Red; and, from the present contour of the land, it would seem its natural course to follow this line of depression to the Avon. But instead of doing so, it leaves the line of depression and cuts a prettily wooded valley through the Dolomitic Conglomerate, which may be seen near the head of the notch to rest on the Old Red. Thus the Stoke Trym does on a small scale exactly what the Avon does on a large scale. The natural course of the Avon from Bristol would seem to be to flow into the sea by Nailsea, thus avoiding altogether the ridge of the Downs. Instead of doing so, its cuts a notch through the Downs. The natural course of the Stoke Trym would seem to be to follow the line of the softer Old Red depression. Instead of doing so, it cuts a notch in the Dolomitic Conglomerate. In each case the explanation is the same; not that a rent has been formed in the ridge to meet the special needs of the stream, but that the notch in the ridge, and the wider and more general depression above the ridge, are the different products of different modes of denudation. The one is due to special denudation; the other to general denudation. When the stream began to cut its notch into the ridge, the ridge *as such* had no existence.

Above the point at which the stream is joined by the Stoke branch, the valley of the Trym is a notch of no very great depth, but with the characteristic vertical cliff which is generally to be seen on one side or both of the valleys cut down into the Dolomitic Conglomerate. Here it calls for no further remark. But near the point of junction of the Henbury and Westbury branches, it is worth noting that it flows in a line of depression of Lower Limestone Shales between the Mountain Limestone ridge and the Old Red hill upon which Coomb House is situated. The Henbury Trym when it emerged from the Mountain Limestone took the course of least resistance through a depression long ago formed in the Lower Limestone Shales, and subsequently filled in with Dolomitic Conglomerate.

The Westbury branch rises in the Mountain Limestone, or rather in the Lias that rests upon it, N.E. of the village of that name. It does not present any features that call for notice.

The Henbury branch, on the other hand, is of great interest. It again exemplifies the notching of a ridge by special denudation. Rising in the Rhœtic some two miles to the N. of Henbury, its natural course, on the present configuration of the land, would seem to be, to flow W., over comparatively low ground, to the Severn. But instead of doing this, it boldly makes for the limestone ridge, and cuts the deep trench of Coomb Dingle, through the Blaize Castle woods. It is scarcely necessary again to point out that this is due to the fact that the low ground above is due to the action of general denudation, and that its gradual lowering was effected during, and not before, the time that the Henbury Trym was exerting its special denuding influence on the Blaize Castle ridge.

It only remains in this connection to point out that the depression to the South of the Blaize Castle eminence may be due to the incoming of the Middle Limestone Shales at this point.

There is one other minor depression on the Gloucester side of the Avon, namely that in the Lower Limestone Shales S. of the Penpole Down. Here we have evidence, from the way in which the Dolomitic Conglomerate is disposed *(see map)*, that the Old Red Sandstone ridge was notched before the deposition of that Triassic deposit.

9.—*The Curves of the Avon.*

The curves and bends of the Avon, as it passes through the Clifton Gorge, and thence to the Severn, are of interest. Mr. Tawney suggested that in the limestone they might have been determined by joint planes. But the point to which I would rather draw attention is that they are very closely connected with the incoming of harder and softer beds.

From the beginning of the Gorge to somewhat beyond the the Suspension Bridge, the river cuts across the strata nearly along the line of their dip. Then it is forced over somewhat to the Somerset shore, probably by the incoming of those upper and harder beds of the Upper Limestone Shales which, as we have seen, are more extensively brought down by the fault on the Clifton than on the Leigh side of the river, and are now being blasted in the river bed near the Gloucester shore.

After crossing the band of the Upper Limestone Shales brought down by the fault, the Avon meets with, and would seem to be deflected on to the Gloucester shore by, the solid Mountain Limestone which was long ago extensively quarried away from this point so as to open out a better view along the river for the sake of its safer navigation. The deflection is, however, only temporary. The river meeting on the Gloucester shore with similar solid limestone (a little further down stream on this side of the river than the other) resumes its original course, cuts across the Middle Limestone Shales, but is strongly deflected to the W. by the incoming of the massive limestone beyond these softer beds.

Beyond this a band of alluvium on the Gloucester shore points to the fact that, even in recent geological times, the river has been eating into the Old Red banks of the opposite shore. This, however, ceases with the incoming of the tough Dolomitic Conglomerate; and the river cuts a tolerably direct course in its original N.W. direction until it meets with, and is boldly deflected by, the Old Red, south of the Penpole ridge.

The question here suggests itself: Why should the river have been deflected by this ridge and not have cut boldly across it as in the case of the Leigh-Durdham ridge? I imagine that the answer to this question is to be found in the fact, that the Avon was here under the influence of that S.W. slope of the land of which the Trym gives us unmistakeable evidence. Be this as it may, the river is here turned nearly at right angles; and as it flows to the S.W. encroaches further and further upon the constantly thicker beds of the Dolomitic Conglomerate, meeting with more and more resistance until, at Hung Road, near Pill, it is once more deflected, across the softer Trias Marls, to the Severn.

10.—*The Somersetshire Tributaries.*

Setting aside the gully caused by the Middle Limestone

Shales, and a little gully marking the point where the Lower Limestone Shales cross the Avon, there are five tributary streams on the Somersetshire side of the Avon.

The first, which I have marked on the map as the Leigh Brook, collects the rainfall in a Lower Limestone Shales depression N.E. of Abbot's Leigh, and in a depression of the Limestone on the Leigh Court estate. The two depressions join near the keeper's lodge, whence the little stream flows in a prettily wooded notch of the Old Red Sandstone until it reaches the Avon.

The second, which I have marked as the Oakham Brook, answers to the Stoke Trym on the Gloucester side of the river; but with this difference, that it follows the depression to the Avon and does not cut a gorge in the Dolomitic Conglomerate, which steeply bounds it on the W., resting on the upturned edges of the Old Red.

The third, or Chapel Brook, collects the rainfall from the Lower Limestone Shales depression S. of Abbot's Leigh, in the manner shown in the map. It then leaves this depression, and notches the Old Red Sandstone ridge, near the N. side of which it is dammed back to form the Abbot's Pool. After this its valley opens out, right and left, as it crosses the softer Old Red rocks, and it receives a little tributary from the W., the depression being less marked on the E. owing to the overlie of Dolomitic Conglomerate. After crossing this depression, the valley of the Chapel Brook narrows to a wooded cleft as it passes through the harder Dolomitic Conglomerate; opens out again where the softer Triassic Marls come in; and narrows once more in the harder Dolomitic Conglomerate through which it finally passes to the Avon.

The fourth, or Markham Brook, follows a very similar course. It collects its head-waters from the Leigh Downs, and from the E. and W. depression of the Lower Limestone Shales. It, too, then notches the harder Old Red, flowing in a narrow valley, which widens out in the softer Old Red, and here receives a tributary from near Failands House, and a smaller intermittent streamlet from the E. Its valley, too, then narrows to a wooded cleft, as it passes through the harder Dolomitic Conglomerate, giving rise to Markham Bottom; opens out in the Triassic Marls above Pill; and then narrows again in the Dolomitic Conglomerate, just before it falls into the Avon.

Nothing could be more beautiful than the way in which these two streams, the Chapel Brook and the Markham Brook, exemplify the differential action of general and special denudation. Where the rocks are hard the valleys are narrow, for here general denudation cannot keep pace with special. Where the rocks are soft the valleys open out, for here general denudation has greater power. At the present relative level of sea and land, the special denudation is going on very slowly, or has almost ceased. But were the land to be elevated to a greater height above the sea level, the more rapid streams would cut their way downwards far more rapidly into the rocks over which they run. In times past, no doubt, at periods of greater rainfall, the streams were more active agents of denudation than they could be with their present dimensions. A more rapid fall, and a larger water supply, probably marked the period of the greatest activity of these streams.

The fifth and last stream, the Easton Brook, rises in the softer Old Red beds and then notches the Dolomitic Conglomerate, at first so deeply as to expose the underlying Old Red Sandstone. After emerging from the constricting Dolomitic Conglomerate, it passes through Trias Marls, and finally over the Severn flats to join the Avon a little S. of Avonmouth.

The lover of nature will find the tracing of such streams as these, downwards from their source, a most delightful occupation.

The notches in the harder rocks are beautifully wooded; their banks, in this early Spring-time, are thickly carpeted with bright Spring flowers, while the whole air seems resonant with the notes of song-birds.

11.—*Conclusion.*

I have thus tried to explain how the physical features of the district N.W. of Bristol are determined, in general and in detail, by the geological structure ; and how all these features are the product of denudation, general and special.

That the Avon Gorge itself is a product of denudation was, as we have seen, long ago pointed out by Professor Jukes. But there still remain sceptics even in the ranks of geologists. My main object in this paper has been to enforce the truth of this explanation by showing that it applies to *all the minor gorges* through which the tributaries of the Avon flow. And I would invite the sceptics to consider, first, the case of such minor notches as are cut by the Chapel Brook and the Markham Brook ; then such an one as is cut by the Stoke Trym ; then that much more marked gorge which is cut by the Henbury Trym through the Blaize Castle limestone ridge; and finally rise from this to the Avon Gorge itself. If they still remain sceptics, I must confess my incompetence to help them to rise into orthodoxy. I can only assure them that the hypothesis of any faulting action along the line of the gorge is completely out of the question. That is proved by the Middle Limestone Shales.

The Clifton Gorge, the result as I contend of special denudation, forms so striking a physical feature that it cannot be overlooked. It appeals at once to the imagination. The results of general denudation, on the other hand, do not affect us in the same way. It is only the geologist who can rightly estimate these results. We cannot so readily realise the *absence* of vast masses of rock, over a wide area of country, as the *presence* of a definite ravine, like the Clifton Gorge. And yet it seems to me that the general denudation which has removed all the Inferior Oolite, not to mention the newer rocks which almost certainly overlaid it, and nearly all the Lias, from our district, demands almost more of our wonder, and our faith in geological principles, than the special denudation which has cut for us the Avon Gorge. Assuredly if we must call upon an inexplicable convulsion of nature to explain the one, we must in like manner call upon a yet more inexplicable convulsion of nature to explain the other.

Finally we must remember that this vast system of denudation yet in progress has revealed to us the effects of a pre-Mesozoic denudation equally vast. Our limestone Downs and our Old Red ridges are physical features which have been *rather reproduced* than produced by our present system of denudation. For long ages these ridges, carved out by the older denudation, lay buried beneath a load of Mesozoic rocks. To remove this load has been the main work of the present system of general denudation, while special denudation has been cutting those notch-like gorges, which break the continuity of the ancient ridges.

NOTE.—I have to express my thanks to Sir Philip Miles, Sir Greville Smyth, and Mrs. Harford for kindly giving me permission to wander at will through their estates.

The section on the Clifton Fault covers the same ground as my paper to be published in the May number of the Quarterly Journal of the Geological Society of London.

The Fungi of the Bristol District.

PART VIII.

BY CEDRIC BUCKNALL, MUS. BAC.

TRICHOLOMA.

1085. Agaricus lascivus, *Fr., var.* robustus. — Failand, Sept. 1884. Coombe Hill, Autumn, 1883.

OMPHALIA.

1086. Agaricus muralis, *Sow.* — Durdham Down, ,, 1884.

ENTOLOMA.

1087. Agaricus repandus, *Bull.* — ,, Sept. ,,

CLITOPILUS.

*Agaricus vilis, *Fr.*, *Cooke, Illustrated t.* 487.

Figured from the Leigh Down specimens, where it occurs abundantly nearly every year. No. 710 is this species, not *Ag. asprellus.*

HEBELOMA.

1088. Agaricus capniocephalus, *Bull.* — Blaise Castle Woods, Aug. 1884.

NAUCORIA.

1089. Agaricus striaepes, *Cooke, Grevillea,* vol. 13, p. 60, *Illus. t.* 478. — Westbury, Oct. 1877.

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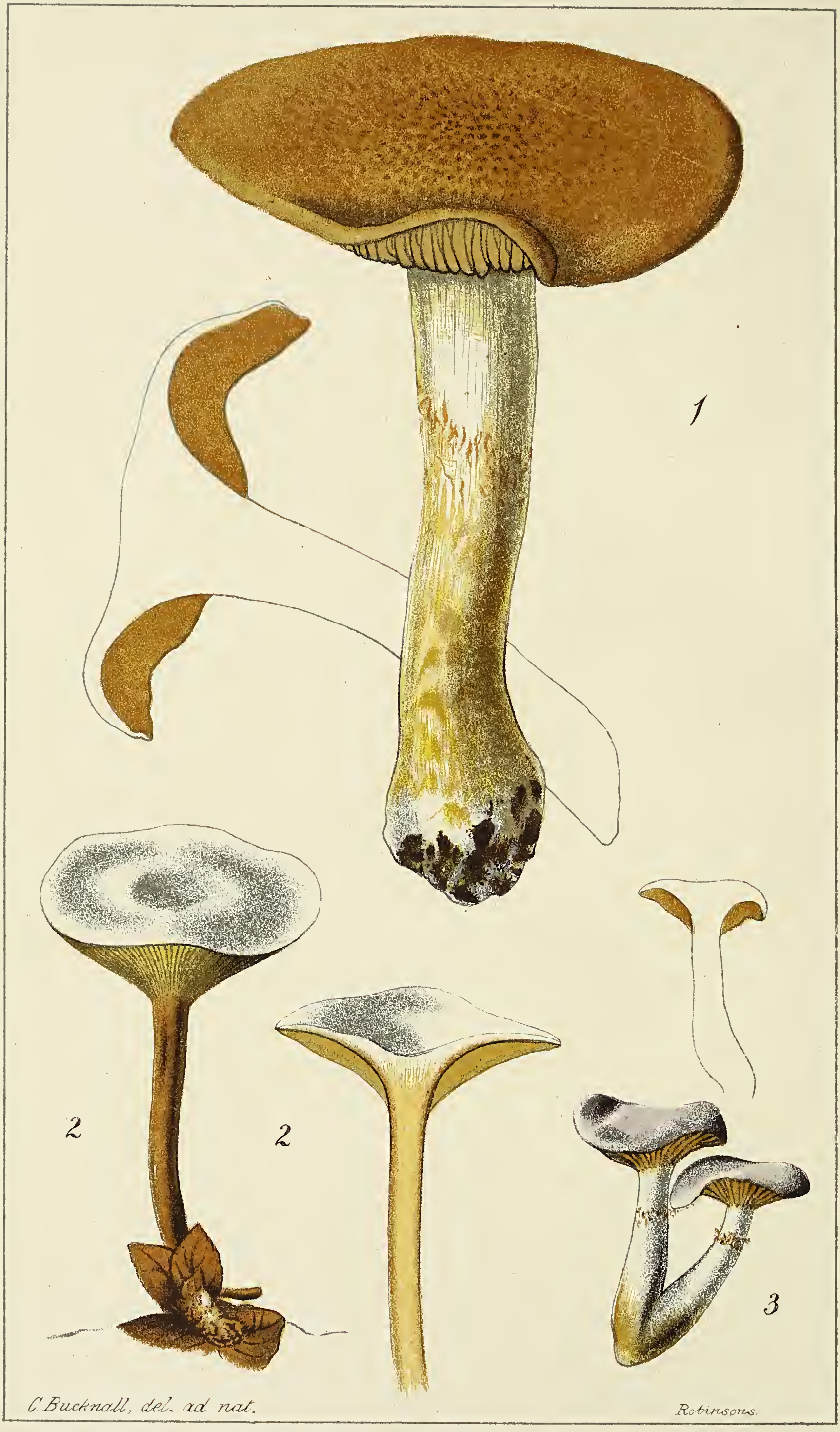
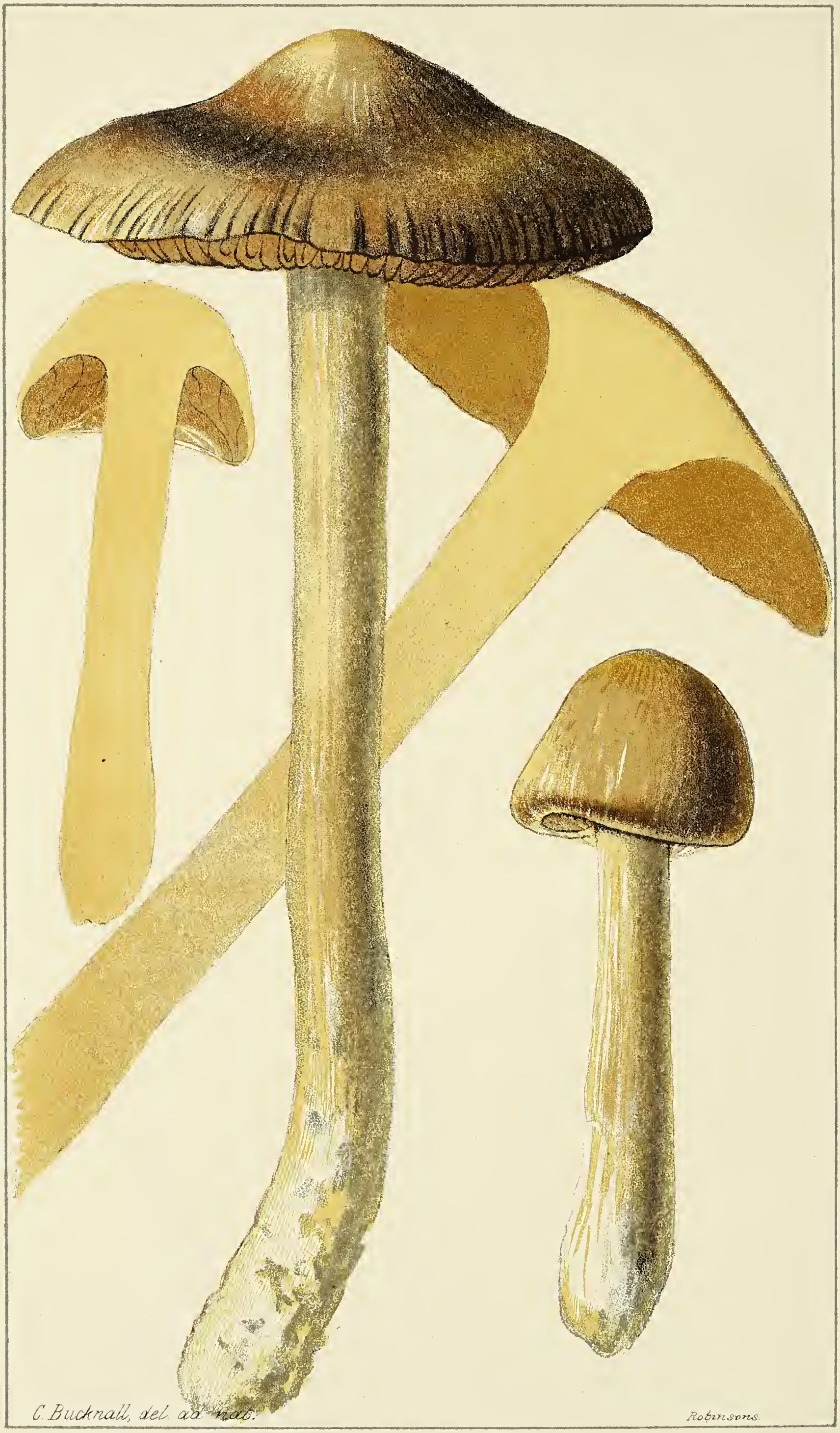


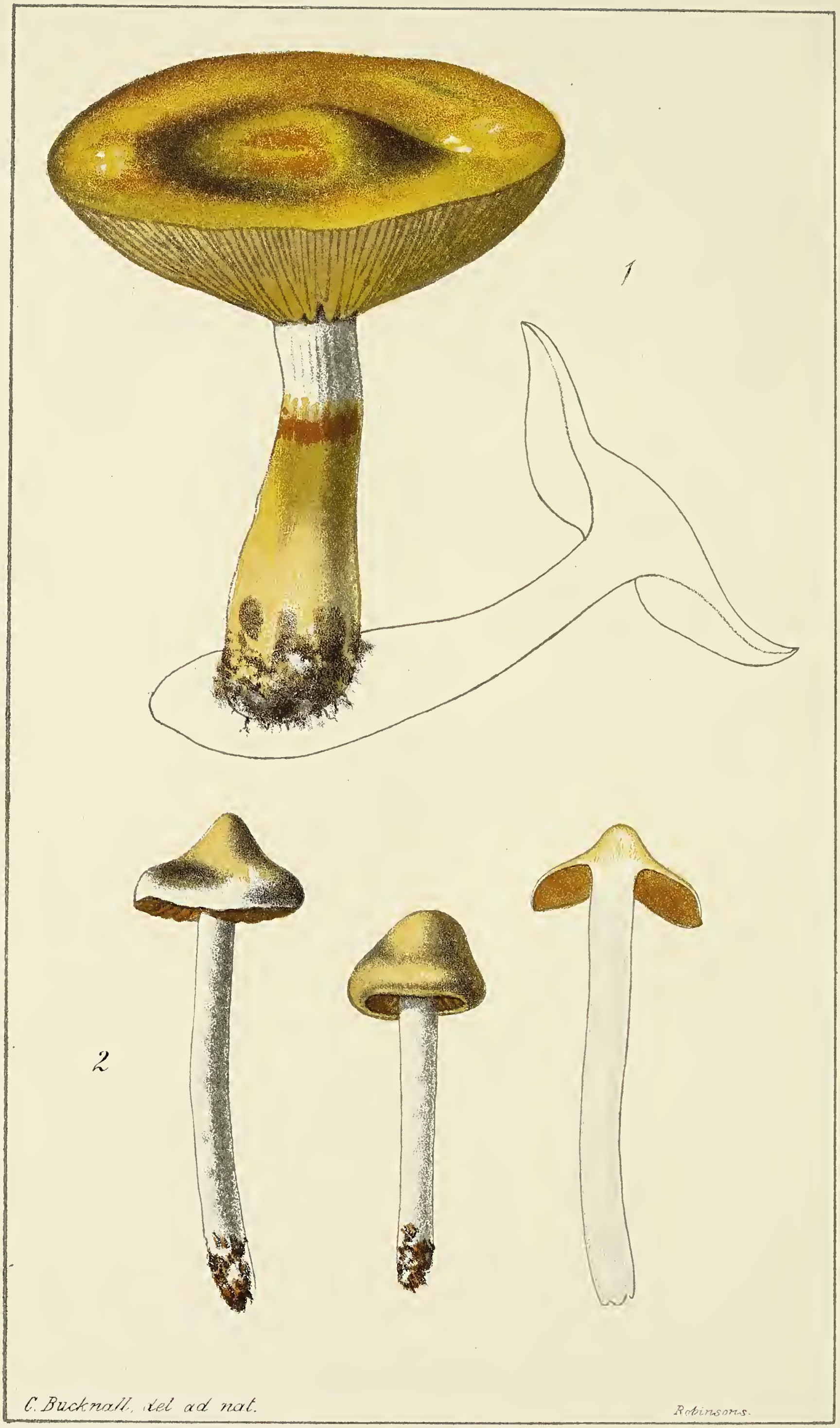
C. Bucknall, del. ad nat.
Robinsons.

1. *Cortinarius papulosus*, Fr.
2. *Paxillus panaeolus*, Fr.
3. *Cortinarius croceo-caeruleus*, Pers.


C. Bucknall, del. ad nat.
Robinsons.

Cortinarius macropus, Fr.

Plate V.


1
2
C. Bucknall, del ad nat.
Robinsons.

1. *Cortinarius arvinaceus*, Fr.
2. *Cortinarius quadricolor*, Fr.

Hypholoma.

1090.	Agaricus leucotephrus, *B. & Br.*	Blaise Castle Woods,	Sept. 1884.
1091.	Coprinus cinereus, *Schaeff.*	Stapleton	,, ,,

Phlegmacium.

1092.	Cortinarius glaucopus, *Fr.*	Durdham Down,	Sept. ,,
1093.	,, fulgens, *Fr.*	,,	,, ,,
1094.	,, croceo-caeruleus, *Fr.*, Plate III., fig. 3.	,,	,, ,,
	*Cortinarius papulosus, *Fr.*, (No. 1042, *ante*), Plate III., fig. 1.	,,	Oct. 1883.

Myxacium.

	*Cortinarius arvinaceus, *Fr.* (No. 1043, *ante*), Plate V., fig. 1.	Blaise Castle Woods,	Oct. 1882.

Telamonia.

1095.	Cortinarius macropus, *Fr.*	Leigh Wood,	Oct. 1884.

Pileus fleshy, convex and incurved, then expanded, obtuse, *hoary with minute squamules*; stem solid, tall, equal, fibrillose, becoming white, ring thin, distant; gills adnexed, distant, very broad, pallid then watery cinnamon. *Fr. Hym., Eur. p. 374.* Plate IV.

	*Cortinarius quadricolor, *Fr.* (No. 1046, *ante.*) Plate V., fig. 2.	Blaise Castle Woods,	Oct. 1882.

Hydrocybe.

1096.	Cortinarius subferrugineus, *Fr.*	Blaise Castle Woods,	Sept. 1884.
1097.	Paxillus lepista, *Fr.*	Frenchay,	,, ,,
*	,, panaeolus, *Fr.* (No. 957, *ante*), Plate III., fig. 2.	Blaise Castle Woods,	,, 1882.
1098.	Russula nitida, *Fr.*	Stapleton.	,, 1884.
1099.	Marasmius amadelphus, *Fr.*	Durdham Down,	Aug. ,,
1100.	Polyporus ribis, *Fr.*	Leigh Wood,	June, ,,

1101.	Thelephora cæsia, *P.*	Tortworth,	July, ,,
1102.	,, arida, *Fr.*	Coombe Hill,	Nov. ,,

Spores elliptic, echinulate, brown, ·009 mm. long.

1103.	Dacrymyces stillatus, *Nees.*	Abbot's Leigh,	April, 1885.
1104.	Actinothyrium graminum, *Kze.*	Durdham Down,	May, 1884.
1105.	Vermicularia trichella, *Grev.*	Leigh Wood,	June, ,,
1106.	Diplodia sapinea, *Fr.*	Haw Wood,	Mar. 1885.
1107.	,, Rubi, *Fr.*	Durdham Down,	May, 1878.
1108.	Hendersonia loricata, *Sacc. & Roum.*	Stapleton, Brentry,	Mar, 1880. April, 1885.

Perithecia gregarious, innato-erumpent, corticolous, globulose, pierced, $\frac{1}{3}$-$\frac{1}{2}$ mill. diam.; structure minutely cellular, fuligineous; spores ovoid, obpyriform, ·022-·028 × ·015-·016 mm., rounded at the apex, 2-3 septate, not constricted, fuligineous, at first nucleate, borne on filiform, hyaline basidia, which are ·010-·015 × ·002 mm. *Sacc. Syl., No. 2410.*

On beech branches.

"Not a good species of *Hendersonia.*" *M. C. C.*

1109.	Cytospora pinastri, *Fr.*	Abbot's Leigh,	April, 1885.
1110.	Synchytrium taraxaci. *De By. & Wor.*	Stoke,	May, 1883.
1111.	Mitrula paludosa, *Fr.*	Abbot's Leigh,	April, 1885.
1112.	Peziza acetabulum, *L.*	Tortworth,	July, 1884.
*	,, leucomelas, *Pers.*	Ashton,	Feb. 1878.

Recorded as *P. acetabulum* at p. 348, vol. II., part II.

1113.	Peziza hæmastigma, *Fr.*	Frenchay,	Feb. 1884.
1114.	,, melastoma, *Sow.*	Hanham,	Mar. ,,
1115.	Lophium (Mytilidion) decipiens, *Karst.*	Black Rock Quarry,	Mar. 1885.

Perithecia gregarious, sessile, erumpent then superficial, rounded or oblong, sub-navicular, acutely keeled, black, even, minute, scarcely exceeding ·3 mm., asci cylindrical, often slightly inflated and curved towards the base, octosporous, ·065-08 ×

·008-·012 mm.; spores in the lower part of the ascus distichous, fusoid-oblong or fusoid-elongated, straight or moderately curved, 3-septate, pale yellow, ·015-·02 × ·004-·006 mm.; paraphyses filiform, flexuous, slender. *Sacc. Syl., No. 5703.*

On bark of *Juniperus communis*, and fir cones.

My specimens are on pine wood.

1116.	Colpoma quercinum, *Wallr.*	Haw Wood,	Mar. 1885.
1117.	Eutypa flavo-virens, *Tul.*	Clevedon,	June, 1884.
1118.	,, rhodi, *Fckl.*		
1119.	Diaporthe pulla, *Nits.*	Brentry,	Mar. 1885.
1120.	,, protracta, *Nits.*	Leigh Woods,	April, 1882.
1121.	,, acus, *Blox.*	Black Rock Quarry,	Mar. 1885.
1122.	,, Arctii, *Lasch.*	The Avon, S.	April, ,,
1123.	,, discors, *Sacc.*	Black Rock Quarry,	Mar. ,,

On dead stems of *Rumex*. Readily distinguished from *D. acus* by the black line which encircles the groups of perithecia, and which is entirely absent in the latter species.

1124.	Diaporthe incarcerata, *B. & Br.*	Leigh Down,	April, 1882.
1125.	Diaporthe blepharodes, *B. & Br.*	,, ,,	,, 1883.
1126.	Diatrype strumella, *Fr.*	Leigh Wood,	June, 1884.
1127.	,, disciformis, *Fr.*	,, ,,	(?)
1128.	Valsa stellatula, *Fr.*	Near Blaise Castle,	April, 1885.
1129.	,, syngenesia, *Fr.*	The Avon S.	Feb. ,,
1130.	,, microstoma, *Fr.*	The Gully.	
1131.	,, coronata, *Fr.*	Near Blaise Castle,	April, 1885.
1132.	,, Curreyi, *Nits.*	Haw Wood,	Mar. ,,
1133.	,, abietis, *Fr.*	Abbot's Leigh,	April, ,,
1134.	,, salicina, *Fr.*	Abbot's Leigh,	Mar. ,,

1135.	,, (Pseudovalsa) aglaeostoma, *B. & Br.*	Leigh Wood,	May, 1882.

On twigs of *Viburnum lantana*, but it appears to be the same as that described as growing on elm twigs.

1136.	Valsa (Coronophora) angustata, *Fckl.*	Brentry,	Mar. 1885.

Perithecia sometimes numerous, disposed in orbicular or oval sori, which are barren in the centre, sometimes few only, circinating, or lastly, altogether solitary, irregularly scattered, concentric or symmetrical, erect or almost decumbent, ovate or globose, rather large, at length collapsing, more or less verruculose, black, glabrous, without a neck, pierced at the apex, often erumpent through the variously fissured epidermis, sessile on the surface of the inner bark, more rarely with the base immersed in its outer layer; asci broadly obovate, very obtuse at the apex, often ventricose at the base, formed of a rather thick membrane, abruptly attenuated into a narrowly filiform pedicel, which is generally five or even six times longer than the sporiferous part, ·032-·036 × ·014-·016 mm. (p. sporif.), the cavity of the asci, or more rarely the asci themselves, narrowed below the apex; spores very numerous, crowded, cylindrical, nearly straight, ·004-·008 × ·001 mm. *Sacc. Syl., No. 414.*

On branches of beech.

1137.	Valsa (Cryptospora) Betulæ *Tul.*	Leigh Wood,	Feb. 1877. May, 1885.
1138.	Massaria pupula, *Fr.*	Brentry,	April, ,,
1139.	,, eburnea, *Tul.*	Leigh Wood,	,, ,,
1140.	Xylosphæria apiculata, *Curr.*	Near the Avon, S.	Dec. 1884.
1141.	Sphæria (Rebentischia) unicaudata, *B. & Br.*	Brentry,	April, 1885.
1142.	Sphæria (Didymella) sepincolaeformis, *De Not.*	Brentry, The Avon, G.	,, ,, May, ,,

Covered by the epidermis, scattered, causing a black spot, encircled with a pallid halo, perithecia lenticular, rotund, thin, black, opening by a scarcely conspicuous ostiolum; asci clavate, octosporous; paraphyses filiform, rather thick; sporidia oblong-pyriform, hyaline, bilocular, lower cell small. *Sacc. Syl. No. 2150.*

On branches of rose, asci ·1 mm.; sporidia ·023-·025 × ·0095 mm.

1143. Sphæria (Metasphæria) corticola, *Fckl.* — The Gully, Feb. 1880.

Perithecia scattered, minute, nestling under the swollen, and, at length, splitting epidermis, globose, black, nucleus grey, at length empty; ostiola scarcely prominent, very short; asci stipitate, cylindrical, ·096 × ·01 mm.; sporidia eight, uniseriate, oblong, obtuse at each end, 3-septate, slightly constricted at the septa, ·016 × ·006 mm. *Sacc. Syl., No. 3442.*

On twigs of sloe.

1144. Sphæria (Metasphæria) Cumana, *Sacc. & Speg.* — Aust, June, 1881.

Notes on a Common Fin Whale
(*Physalus antiquorum*, Gray,)
# lately stranded in the Bristol Channel.

By E. WILSON, F.G.S.
(Curator of the Bristol Museum.)

ON January 15th, 1885, a large whale was washed ashore dead, at Littleton Pill, an inlet on the east side of the estuary of the Severn, and about five miles north of the Severn Tunnel. The whale was first observed by the foreman of Mr. G. Wintle, brick manufacturer, Elberton, who had it towed up the inlet and moored to the wharf near his brickyard, at some little distance from the shore. On visiting the spot two days afterwards, I found the animal lying on its back at the bottom of the Pill. Though not then able to examine the body closely, I saw enough to satisfy me that this whale belonged to the group of Cetacea termed the *Balænopteridæ*, or Finner Whales, and to the species popularly known as the Common or Great Northern Rorqual—the Razorback or Fin Whale of the whalers—and scientifically as *Physalus antiquorum* (Gray), or *Balænoptera musculus* (Fleming).*

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* To avoid mistake, I may remark that these are some of the best known names among a long list of aliases. See Catalogue of Seals and Whales in the British Museum, by Dr. J. E. Gray, F.R.S., 2nd ed., 1866, p. 144.

Eventually the animal was taken to Bristol.

The following details as to the external characters and the dimensions of this great whale are the result of a careful examination of the body since its arrival in that city:—The animal was a female of about the average size, the total length of the body being 66 ft. The belly (*i. e.*, the ventral surface of the throat and thorax) was traversed by numerous longitudinal shallow grooves, parallel to one another, running backward from the inner edges of the lower jaw beneath the pectoral fins, and ending posteriorly along two lines drawn obliquely from beneath the pectorals to a median point ventrally about 9 feet behind their termination. Occasionally adjoining grooves blended with one another, uniting obliquely. The colour of the body was black above, *i. e.*, on the head and jaws, back and sides, down to an irregular line passing from beneath the lower jaws and the pectoral fins to the termination of the tail ventrally. Below, the body was white, namely on the belly and also on the abdomen and ventral surface of the tail along a triangular shaped area having its apex at the tail-fork. When the whale was found the white colour of a good deal of the belly region was tinged with a deep pink, owing to the rosy-coloured epidermis which in this species lines the hollows of the ventral plicæ. By the time the animal reached Bristol, however, this pink colour had entirely disappeared, apparently as a result of the decomposition then rapidly progressing. The lateral portions of the white belly region were mottled with a few large irregularly shaped, dark patches, an especially large one lying beneath each pectoral. The black colour of the dorsal region shaded off gradually into the white below. In the white area bordering the dark region there were, in addition to the larger patches above mentioned, occasional dark spots and dashes in the ventral grooves. In the posterior portion of the body (tail) the two diversely coloured regions were more sharply defined.

The epidermis was thin and easily rubbed off; thus the dark pigment it contains may be lost through a little friction and parts appear white which in the living animal are black. Seeing that the whale was lying on its back I had not a good opportunity for studying the dorsal features. The head had a very depressed and flattened contour, I should estimate its length at about 17 feet. There was not, however, visible any external sign of division between the head and the trunk. In the position in which the animal lay the back appeared almost flat; in life it would present a regular and depressed curve from the snout to the tail-fork, broken only by the prominent dorsal fin. The caudal portion of the trunk was much compressed laterally, and had a proportionately great vertical depth —a very characteristic feature of this whale and its immediate allies.

The pectoral fins (flippers) were given off 21 feet behind the nose; they were of moderate length (7 feet as measured along their lower edge), lanceolate in shape, and in colour black exteriorly and probably interiorly also in the living state.* The dorsal fin was set far back on the tail, its commencement and termination being respectively 49 feet from the nose and 14 feet in front of the tail-fork; it was prominent, erect, and compressed laterally. The horizontal tail-fin had a considerable breadth of union with the hind end of the body. One lobe is convex and the other concave, thus giving to this fin the characteristic screw-shaped contour. Each lobe projected seven feet from the body, giving a total span for this powerful organ of propulsion of no less than fourteen feet.

The eye was extremely small relatively, and at a slight distance hardly discernible. It is placed on a prominent part of the head a little above the angle of the mouth. In figures of this, as probably also in those of several other whales, its size is greatly exaggerated. The blow-holes I could not see owing to the position of the animal. The sexual orifice was placed almost directly beneath (just in front of) the dorsal fin. The anus was immediately behind.

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* When I examined the animal in Bristol the inner surface of the pectorals appeared to be white. As to this, however, note what is said above in regard to loss of colour.

The jaws were of about equal length, the lower jaw *very slightly* projecting. In describing a male whale belonging to this species, 61 feet in length, stranded near Portsmouth in 1868, Dr. W. H. Flower, F.R.S., states that the lower jaw projected eighteen inches beyond the upper.* In this respect the Littleton whale certainly differs from the Portsmouth whale, the jaws being practically of equal length. The upper jaws are much narrower than the lower, and run pretty straight forwards to the pointed nose. The upper jaws are lined with baleen (whalebone) running all round a little within their outer margin. The baleen consists of numerous thin and closely set plates, imbedded in the gum of the upper jaws, from which they are suspended vertically. They are arranged transversely to the long axis of the jaw, on each side, in several (four) continuous series, which rapidly diminish in size inwardly, thus giving the whole palatine surface (with the exception of a smooth median ridge which is not occupied by whalebone) an elegant arched form. Into this arch, when the mouth is shut, fits the animal's enormous tongue. The baleen plates are *slightly* curved, the convex surfaces being directed forwards. On removal from the body they shrink somewhat in drying and thus acquire a more pronounced curvature or spiral twist. The baleen plates vary considerably in different parts of the jaw, both in form, size, and colour. They are generally of a triangular shape (viz., an acute right-angled triangle with the long side of the right angle exteriorly, the hypoteneuse curved and interiorly, and the short side forming their attached base) and taper away to a point at their free ends. Their inner edges are fringed with more or less elongated bristle-like fibres, of a yellowish white colour. These bristles are the prolongations of the stout fibres of which the baleen plates consist, *minus* the investing layers of enamelled substance which cover those plates. This bristly portion becomes proportionately greater as the plates become less. The outer and principal series of baleen plates (the labial plates) attained their maximum dimensions both in length and breadth near the middle of the jaws. They were here fully 2 ft. 6 in. long, from 9 to 10 inches broad at their base, and $\frac{1}{10}$th of an inch in thickness. In a general way they are of a pale greenish grey colour, with alternating dark and light coloured longitudinal (*i. e.*, vertical to the base) streaks at pretty regular intervals. Taking one of the largest plates as a typical example, we notice that its outer portion for a width of three or four inches is of a dark slate colour, with hardly perceptible streaking, whilst the remainder of the plate for a width, at the base, of six or seven inches, is of a pale grey with, at first, several narrow horn-coloured streaks at regular intervals, and then with a few alternating broader and less regularly distributed cream-coloured bands edged with dark linear streaks, which prevail until the inner edge is reached. Such a plate is quite a striking object. The baleen plates diminished in size regularly, or rather in a graceful curve, and became paler in colour, going towards the snout; they also diminished in size and became whiter in colour towards the mouth angles. At the snout the plates were not more than five or six inches in length by two inches in breadth, and were here entirely of a yellowish white colour. The whalebone of this as of the other Finner whales is of very little commercial value, being only used to split up into an inferior kind of false bristles. It is, however, of considerable scientific interest,

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* P. Z. S., 1869, p. 604, pl. xlvii., f. 1.

and furnishes important characters for the discrimination of the different species.

When I first saw the whale at Littleton Pill, although it was then in the middle of winter, and the temperature was very low, scarcely indeed above the freezing point, decomposition had already set in. As a consequence of this the "belly" had become enormously distended, and the by no means ungraceful form of the animal had become greatly distorted. An accurate delineation of the whale as seen in the living state was therefore impossible. Fortunately several photographs were taken. The accompanying figure is a platinotype produced from a negative taken by Mr. F. A. Orchard, Photographer, Stapleton Road, Bristol, on the 26th January, eleven days after the animal's discovery. Allowing for the unavoidable distortion of the anterior portion of the body from the cause mentioned above, it faithfully represents the whale, or at any rate its latero-ventral aspect. The men in charge informed me that the distension of the animal had, to a great extent, taken place since it had been first observed. What the cause of death of this whale was it is impossible to say. Seeing that its body was stranded on a shore at some distance from the nearest coast (Cornwall) ordinarily frequented by these animals, and that it had already begun to decompose, the probability is that it had been dead some little time, several days at least, I should say, and had subsequently been floated up the estuary with the tide. The animal lay in the Pill for about a fortnight. During this period, as also after reaching Bristol, it was visited by many thousand people, for whose accommodation special trains were run by the Midland Railway Company. The body was claimed by the lord of the manor, and also by the agent for the Crown, as "flotsam and jetsam." The latter carried the day and sold the carcase by public auction, when it was knocked down to Messrs. Kent and Cottrell, Artificial Manure Manufacturers, of Bristol, for the sum of £40. On January 29th the enterprising purchasers had the whale towed down the estuary and up the river Avon by a steam tug, and subsequently by six horses to their works at St. Philip's Marsh, Bristol. Here, having floated the monster ashore with a high tide and enclosed it within a hoarding, they exhibited it to the public for about a fortnight. The animal was then cut up, the flesh being converted into animal manure, whilst the skeleton has been preserved as an anatomical specimen.

On the newly-discovered Phenomenon of Apospory in Ferns.

By CHARLES T. DRUERY, F.L.S.

I HAVE been invited to address you this evening with the object of bringing before your notice certain new phenomena of reproduction which have been recently discovered upon two of our native British ferns. My personal observations, however, relate more especially to one of these ferns, viz., *Athyrium Filix-fœmina,* var. *Clarissima,* an exceedingly beautiful variety found growing wild in North Devon, for whose present existence we are indebted to Colonel Jones, of Clifton, who detected its beauty under very adverse circumstances, and saved it from destruction, to which it had been doomed by the neglect of the original finder.

Before, however, I proceed to explain to you the nature of the phenomena in question, I will make a few preliminary remarks elucidating the normal mode of reproduction in ferns, since to those who have not made a special study of the subject the peculiar interest attaching to the abnormal method discovered in connection with the *Athyrium* in question may quite possibly be missed, while those who have acquired a knowledge of the various ways in which ferns propagate themselves will, I am sure, pardon the little delay which my remarks will necessitate.

In the first place, I may indicate the great difference which exists between the reproductive phenomena common to the higher orders of vegetation, such as flowering plants, and that of the cryptogamic families to which ferns belong. In the one case the reproductive organs, viz., the flowers, are almost invariably among the most conspicuous parts of the plant, and the manner by which the process of fertilization is effected is easily investigated. The flower is provided with a very evident ovary, to which is attached the stigma: these represent the female organs. Then there are the stamens or male organs, the pollen grains from which, falling upon the stigma, develop tubes which pass down it to the ovary and fertilize it, the result being seed capable of reproducing the parent form. This seed, finding a suitable nidus, sends out roots into the soil, and leaves into the air, and the plant, without further complication, takes on the form of its parent.

With ferns, however, the process is so much more complex, and the whole of the reproductive action is conducted on a scale so excessively minute, that we cannot wonder at the slow progress which was made in the discovery of the *modus operandi;* it being in point of fact only forty years ago that the last step was attained in the investigation of the normal mode of their reproduction, by the discovery that ferns, like flowers, were the result of sexual action, Naegeli discovering the antheridia, or male organs, in 1844, and Suminski the archegonia, or female organs, two years later.

Probably one of the greatest obstacles to the earlier discovery of the true nature of the phenomena lies in the fact that the first result of the germination of a fern spore is the production not of a fern, nor anything resembling one, but of a small flat green disc, very like a young liverwort, upon the under surface of which the antheridia and archegonia are produced, and the fertilization takes place which results eventually in the reproduction of the parent fern.

In ferns, moreover, the sori or heaps of capsules containing the spores or reproductive bodies are borne normally upon the backs of the fronds, a feature constituting one of the most salient differences between ferns and flowers, and one which for a long time threw observers off the scent regarding their true nature.

The sori in one family—the Polypods—are destitute of a cover, but in the large majority of cases are furnished with an indusium. The sorus consists of a variable number of spherical capsules, termed sporangia, which, though themselves only just visible to the naked eye, contain each a large number of absolutely microscopic bodies termed spores, very many millions of which are produced upon a fern frond of very moderate size.

When these spores are ripe, they are scattered by the sudden bursting of the sporangium, caused by the contraction of a ring, which in most cases wholly or partially surrounds it.

We here arrive at another great point of difference between ferns and flowers, the spores thus scattered differing essentially from a seed, inasmuch as they are not the product of a process of fertilization. Their function also is not that of reproducing the parent form directly, but to give rise to another form capable of bearing the equivalents of flowers, and thus bringing about that sexual action which Nature seems almost invariably to require for the perpetuation of a species.

The spore then, by a process of cell generation, develops into a prothallus, which, after the first few cells have proceeded from the spore, develops and supports itself by means of root-hairs upon its under surface. After a time the growing point stops short, and the sides grow out and on until it assumes more or less of a heart shape, at which stage, and when it is on an average from $\frac{1}{8}$ to $\frac{1}{4}$ inch across, the antheridia and archegonia may be easily detected, the former scattered among the root-hairs, and the latter clustered together upon a thickened cushion of cells in the indentation of the prothallus. The next process is the rupture of the antheridia, from which issue numerous spermatozoids which, aided by the moisture, which in a congenial atmosphere is deposited upon the under surface of the prothallus, make their way to the archegonium and fertilize the ovary seated at its base, the result being a plant resembling the fern from which the spore originated. From this description it will be seen that the prothallus represents the flower of the higher orders of plants in so far that it bears the homologues of the stamens and stigma in the forms of the antheridia and archegonia, and also the ovary and ovum. The spermatozoids take the place of the pollen grains, but seem endowed with a certain amount of volition in addition to power of locomotion, as they have been observed to travel direct towards the archegonia, and I am informed by Prof. F. O. Bower that they have made their way unmistakeably towards simulated archegonia, consisting of minute applications of malic acid to the surface of the prothallus, a fact which points to sensory organs of some sort.

It will be seen from the preceding remarks that in the normal development of ferns the prothallus constitutes a separate generation, and it would therefore form an approach to the higher orders of plants, did the prothallus spring direct from the parent plant, instead of through the mediation of the spore; since the fern would then be the bearer, if not of flowers proper, at any rate of their homologues.

This phenomenon then, viz., the production of the prothallus upon the parent plant without the mediation of the spore—*i. e.*, apospory—is precisely that which has rendered Colonel Jones' *Athyrium Filix-fœmina*, var. *Clarissima*, so remarkable, since it is upon that plant that this peculiarity has been first observed.

In connection with this discovery I may mention that Prof. Thiselton Dyer considers that it exhausts the obvious possibilities with regard to the reproductive methods of ferns; he also recounts the various steps which have led up to it, and gives the dates and discoveries thus :—As far back as

1597	Gerarde	observed	seedling plants near parents,
1648	Caesius	,,	sporangia,
1669	Cole	,,	spores,
1686	Ray	,,	hygroscopic movements of sporangia,
1715	Morison	raised	seedlings from spores,
1788	Ehrhardt	observed	the prothallus,
1789	Lindsay	,,	germination of spores,
1827	Kaulfuss	,,	development of prothallus,
1844	Naegeli	,,	antheridia,
1846	Suminski	,,	archegonia,

which completed the phases of the normal development.

This was followed by the discovery by Prof. Farlow, in 1874, of an abnormal mode of reproduction called apogamy, which consists in the occasional development of the fern by direct bud growth from the prothallus without the intervention of the sexual organs, a phenomenon which is the direct converse of apospory, which we are met to consider; the fern in the one case growing direct from the prothallus by a simply vegetative process, and the prothallus in the other growing in like manner directly from the parent fern.

The discovery of apospory having, however, been preceded by that of sundry other forms of proliferation upon our native Athyria, which really led up to it, I would still claim your indulgence for a few minutes in order to detail to you the successive steps in question.

In September, 1882, whilst examining a batch of very young plants, raised from spores sent me by Mr. P. Neill Fraser, of Edinburgh, I was struck by the appearance of two whitish dots upon the first frond which had risen from the prothallus of an *Athyrium*. On closer investigation with a lens, I was forced to the conclusion that they were bulbils, though I could scarcely credit it; as to my knowledge no proliferous form of *Athyrium* was known, a belief which all my enquiries at the time confirmed, though later on I ascertained that Mr. Mapplebeck had raised plants from similar bulbils, though only the verbal record of the facts remained, and the proliferous forms had apparently not been perpetuated. Pursuing my researches, I found, about a fortnight later, another altogether different form, far more proliferous than the first, the primary frond bearing no less than seven bulbils.

In the former (*Fig.* 1), instead of the simply palmate form usually assumed by the first frond of an *Athyrium*, it is bipinnate and very foliose; the figure is, of course, immensely enlarged, the whole plant at that stage being about ¾ inch high only. The buds upon the first frond proceeded, without any dormant interval, to develop small pinnate fronds, and also aerial roots, which latter grew so vigorously that they projected themselves into a mound of soil raised at a distance of half an inch from the back of the frond. The second frond produced four buds which, however, remained dormant through the winter, the season being already far advanced when they appeared. All the buds, however, produced eventually independent plants, which did not prove to be proliferous; nor did the later fronds produced by the parent fern, which turned out to be a crested form of very ordinary type.

The second example (*Fig.* 2), however, has proved a constantly proliferous form, bearing two sorts of fronds belonging to the *uncum* strain, to which, by the way, Mr. Mapplebeck's plants belonged, a fact which confirms the correctness of the verbal record. One type of frond is long and narrow, but slightly crested and barren of bulbils; the others, however, are densely crested *à la acrocladon*, and the bulbils are so densely scattered among the divisions of the crests that they have, when opened out, the appearance of being peppered. If these crests be layered in the autumn a little forest of young ferns rises from the spot in the spring. This form, in its earliest stage, will be

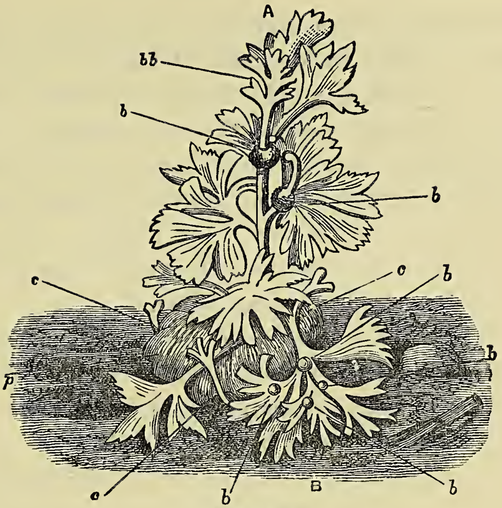

*Fig. 1.**

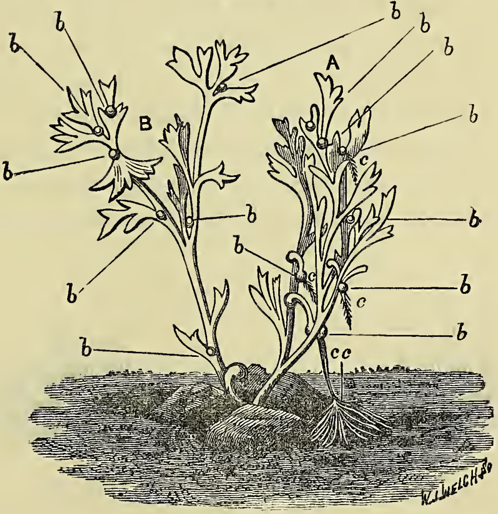

*Fig. 2.**

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* Figs. 1 and 2 copied, by permission, from the *Gardeners' Chronicle* (December 16, 1882, and December 22, 1883).

seen by the figure to be a very curious one indeed. The first two fronds developed no less than 14 buds in the autumn of 1882, some of which, as in *Fig.* 1, threw out aërial roots which in one case, as figured, reached the soil. Strange to say, these two fronds persisted through the winter in my cool fernery, and in the following January resumed growth, forking dichotomously over and over again at the tips of the pinnules, and producing many more bulbils in the process. In point of fact, the two first fronds yielded a pot full of young plants.

One extraordinary feature of this proliferousness is the extreme precocity of the plants, bulbils usually being produced only on the ripe fronds of mature ferns, while these had only just emerged from the prothallus.

These two plants were exhibited at the Linnean Society in November, 1882, and six others from the same batch and of the same type developed eventually bulbils in their crests, but not to such a degree as in the first find, nor at so early a stage.

Stimulated by this discovery I pursued my researches, and in 1883 I was able to record the discovery of the proliferous character of the Athyria in another and most unexpected direction, viz., the plumose varieties. On September 18th I was examining a large specimen of *A. F.-f. plumosum divaricatum*,

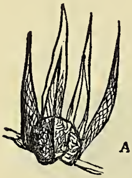

*Fig. 3.**

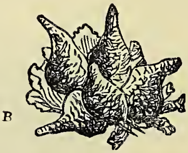

*Fig. 4.**

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* Figs. 3 and 4 copied, by permission, from the *Gardeners' Chronicle* (December, 1882 and 1883).

and was much struck by the fact that, in place of sori for which I was searching, the under surface of the pinnæ was studded profusely with minute nodules, surrounded, shuttlecock fashion, by scales. Applying a lens, I found the central excrescence to be rounded and of a brilliant green, while the scales were of a symmetrical lanceolate shape and beautifully reticulated. (*Vide Fig* 3.)

My immediate impression was that they were bulbils, which, however, I could hardly credit, as to my knowledge no fern, British or exotic, had been known to produce bulbils on the *under* side of the fronds, and in the place of the sori. Determined, however, to try the question practically, I laid down several pinnæ, under side uppermost on sandy soil, the result being that on October 31st I was able to report to Mr. G. B. Wollaston that their bulbil character was established, since in one case a frond with three pinnae had arisen, and in many cases the circinate form had been assumed by less developed ones. In reply to this announcement, Mr. Wollaston informed me that my discovery of this form of proliferousness had been anticipated, though upon another form of Athyrium, and only a few weeks previously; since on September 6th he had seen a plant of *A. F.-f. plumosum elegans* in the possession of Mr. Carbonell, of Usk, upon which similar bulbils had just been discovered by his gardener, Mr. Cropper. Mr. Wollaston, however, added that, so far, no signs of development into plants had been visible, and that to the best of his belief I was the first to raise plants. Colonel Jones, however, on a subsequent visit reported that minute fronds had appeared, as in my case. I may add that in the following spring Mr. Wollaston, myself, and, I believe, others, had succeeded in raising plants. On pushing my enquiries further I elicited the fact that presumed bulbils had been discovered by Mr. Stewartson on another plumose form, and also many years previously by Mr. Lowe upon the Axminster plumosum, the parent of *A. F.-f. plumosum elegans;* but that, until the autumn of 1883, their true character as bulbils had not been established, as repeated attempts had failed to do more than induce the formation of one or two fronds without roots or any apparent independent axis of growth, the said fronds dying as the parent frond lost its vitality during the winter. Mr. Moore, in his "Nature Printed Ferns," apparently makes the only allusion to this pseudo-proliferous phenomenon, as he speaks of the occasional transformation of sporangia into little bunches of leaves, which exactly describes the case as it stood anterior to 1883.

With regard to *A. F.-f. plumosum elegans*, there is a special interest attaching to the fact which I observed, that not only does it bear bulbils proper and sori proper intermingled, but also intermediate transitional stages, which I am very sanguine will throw some altogether new light upon the transformation of the sori into bulbils and the indusia into scales. With this view I have provided Prof. F. O. Bower, of whom more anon, with a portion of a frond bearing ample material for the elucidation of this problem. Prof. Bower has kindly undertaken to investigate this point by means of microscopic sections, &c., and a report thereon will, I hope, appear in the course of the year.

The next discovery, to which the foregoing ones led, was that of the singular and altogether different phenomena presented by *A. F.-f. Clarissima*, with regard to which I cannot, I think, do better than repeat to you verbatim the reports which I laid before the Linnean Society, in 1883 and 1884, and the confirmatory observations of Prof. F. O. Bower, of the Joddrell Laboratory, who received from Professor Thiselton Dyer the material which I sent him with a view to that minute and thorough investigation which only professional skill of a very high order is able to conduct.

Reprinted, by permission, from the Linnean Society's Journal—Botany, Vol. XXI. (Read June 19th, 1884.)

"The reproduction of the Filices by their spores result from sexual action taking place upon the under surface of the prothallus to which the spore gives rise. So far, I believe, no development of the perfect prothallus has been observed without the agency of the spore, and the following record of such a case therefore deserves special notice."

"Some years ago a very distinct and beautiful form of *Athyrium Filix-fœmina* was found wild by Mr. Moule in North Devon, from whose possession it passed into that of Colonel Jones, of Clifton. Many attempts were made at the time to propagate it from what were assumed to be spores, always, however, without success; and at length it was taken for granted that the peculiar growths produced by this fern in the place of sori were merely abortive spore-cases, and that the plants, like some other abnormal forms, lacked the special vigour necessary for the formation of perfect reproductive spores. All further attempts at raising it were consequently abandoned; and only two divisions of the plant exist.* In the autumn of 1883 I discovered upon another *Athyrium* (*A. F.-f.*, var. *plumosum divaricatum*) numerous proliferous bulbils occupying the place of sori on the back of the fronds; and, reporting this to Mr. G. B. Wollaston, he was led to re-examine *A. F.-f. Clarissima*, as the fern in question had been named by Colonel Jones, and came to the conclusion that these so far barren excrescences might be viviparous growths of a kindred nature, and capable of reproducing the parent form by direct bud-development. A portion of a frond was consequently sent to me, and upon examining it under the microscope I found that there were very material structural differences between the unmistakable bulbils of *A. F.-f. divaricatum* and the singular growths upon *A. F.-f. Clarissima*, the former being solitary bud-like growths seated in the centre of a number of brown lanceolate scales and without a trace of indusium (*Fig. 3*); while the latter were composed of 5 or 6 or more flask-shaped bodies, each one larger than the bulbils aforesaid, and seated within an undoubted indusium (*Fig. 4*). The masses were sufficiently large for their formation to be clearly distinguishable by the naked eye, covering more than the space of an ordinary sorus. At this stage no signs of spores or spore-cases could be detected, nor could any axis of growth be perceived; so that it was impossible to form any theory as to the eventual mode of reproduction which might result; for although the tips of the flask-shaped pseudobulbils were in some cases elongated into filiform processes, no sign of circination or resemblance to fronds was visible, added to which the presence of an indusium in the place of the scales common to true bulbils led to the assumption that they were abnormal sporoid growths, and not proliferous ones likely to produce plants by direct bud-growth."

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* It is, of course, open to question whether the excrescences formed prior to 1883 were of exactly the same nature. Colonel Jones inclines to the belief that they approached more nearly the character of sori, and did not in previous years present the same appearance as now described.

"To test their capabilities I laid down on November 27, in a duly prepared seed-pan, numerous pinnæ, which I imbedded edgewise half way in the soil, the growths being thus brought into immediate contact with it, lying as they did along the rachides of the pinnæ. I then placed the pan in slight heat, with the result that the pseudobulbils immediately began to increase in size and to develope in such a fashion, that on December 24 I was able to record an evident foliaceous extension and division of the tips of the pseudobulbils, and the appearance of numerous long, rigid, glassy-looking rods of hairs which sprang from their bases. These rods bore a strong resemblance to the root hairs common to the under sides of prothalli; but their decided upward growth, radiating stiffly, seemed opposed to this view, as also the fact that they sprang from the bases and sides of the pseudobulbils. It is probable, however, that they acted as aerial roots, for the growth of the tips of the pseudobulbils proceeded rapidly, until, on February 10 of the present year, I recorded that they had assumed a decided prothalloid form, while the upright rods had either become deflected or absorbed. Eventually all the tips of the flask-shaped bulbils assumed the form of perfect prothalli of the usual size and shape, the pseudobulbils themselves being absorbed and disappearing, and the usual root-hairs developing under the prothalli. On March 17 several of these prothalli were examined microscopically, both by myself and by the Rev. Mr. Aubrey, of Salisbury (to whom I am indebted for aid in observing the final stages of growth), and well-developed archegonia were found in the usual place and number, but so far neither of us was able to detect antheridia. Early in May, however, I succeeded in finding a single antheridium; and it is manifest that many others must have been present on the prothalli not examined, as on May 21 the final stage was reached, small fronds being visible in several cases, projecting from the bifurcation of the prothallus, and evidently therefore produced from the archegonia by the ordinary sexual mode of reproduction; though the prothalli, as has been shown, had developed from growths that differed widely from spores in their form, their size, persistent adherence to the pinnæ, their production of root hairs from their surface, and, finally, the development of the prothallus from their apices by simple extension of growth."

"Lest it might be assumed that these prothalli may after all have resulted from true spores scattered amongst the excrescences described, it should be borne in mind, first, that no spores or spore-cases could be distinguished when the pinnæ were laid down; secondly, that all attempts to raise this fern from spores have failed; and finally, that the entire development of the prothallus from the pointed tip of the pear-shaped pseudobulb—its dilatation, bifurcation, and gradual assumption of the true prothallus form—has been carefully watched and noted step by step, not merely in one case, but in many, in all of which the prothallus was evolved in the same way precisely."

"Where, as in this case, the whole phenomenon is new to the observer, many points of interest are apt to be overlooked, their importance being unknown until too late. Another season's growth may therefore confidently be expected to throw more light upon this development, and especially in relation to the first appearance of the pseudobulbils themselves, which only came under close observation when already of considerable size.'"

"In framing this account of the occurrence, I have confined myself as strictly as possible to a simple and, I hope, clear record of the phenomena observed during the various stages of growth of the abnormal sporoid excrescences under observation. In conclusion, however, I may be permitted to point out, in connection with such phenomena that, so far as formal records are concerned, the family of *Athyria* has hitherto been remarkable for the nonproliferous character of the fronds, which, considering, first, its near relation to the *Asplenia*, so many of which are profusely proliferous, and, secondly, the protean nature of the family itself, is a singular fact. The discovery, however, of numerous proliferous buds which appeared upon some very small plants, which I exhibited here in 1882, led me to institute further inquiries into this subject. I then ascertained that Mr. Mapplebeck had already observed the same phenomenon, and raised plants from similar bulbils, which appeared identical in position and character with those of the *Asplenia*. Last year, as already remarked, I found another and very distinct form of proliferation on a mature plant of *A. F.-f. plumosum divaricatum*, upon which numerous bulbils were evolved in the place of the sori; this, be it observed, being on the under side of the pinnæ, a most unlikely place for such growths. This same transformation of the reproductive energy had already been observed on three other kindred forms of *Athyrium*, upon one of which bulbils and sori were scattered almost indiscriminately over the back of the fronds, some of the sori seeming to be in an intermediate amorphous condition; though in all other cases, so far as I could see, the sori and bulbils were distinctly differentiated by the presence, in the former case, of an indusium, and in the latter of lanceolate scales arranged shuttlecock fashion round the bulbils, no trace of indusium existing. Such bulbils had, until this season, failed invariably to yield plants, and seemed incapable of forming a proper axis of growth. Mr. G. B. Wollaston has, however, succeeded in obtaining plants this spring from *A. F.-f. plumosum elegans*, and one or two of those from *A. F.-f. plumosum divaricatum* have developed fresh fronds with me."

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Plate VI.

Fig. 3.

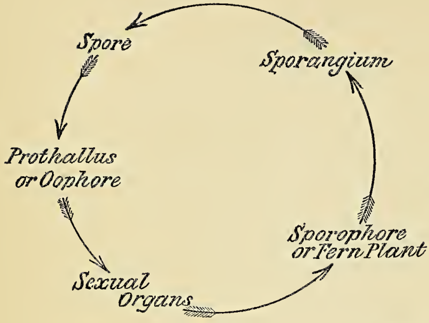


Fig. 5.

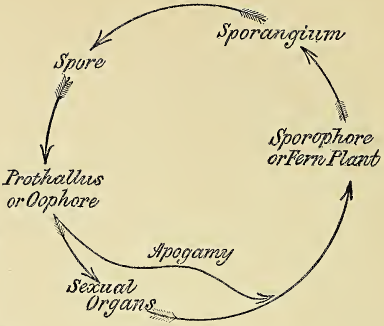


Fig. 4.

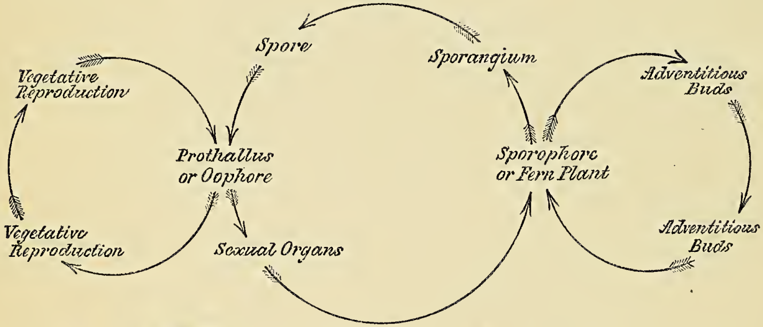


Fig. 1.

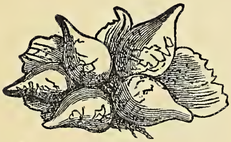


Fig. 2.

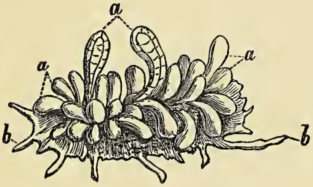


Fig. 6.

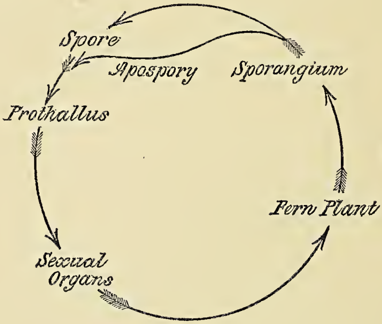


Fig. 7.

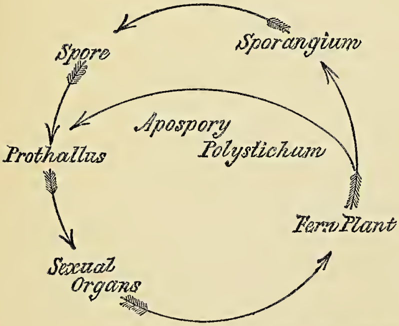
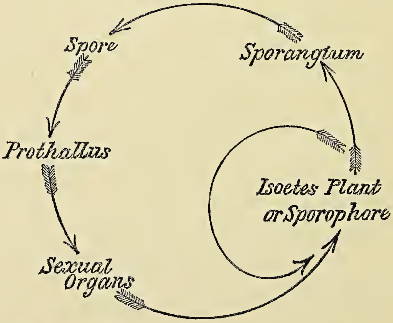


Fig. 8.



APOSPORY IN FERNS.

"From this it will be seen that no less than three distinct forms of proliferation have now been observed on the *Athyria*."

"1. Bulbils of the ordinary character developed in the axils and on the superior surface of the pinnæ, and agreeing in character with the ordinary bulbils of the *Asplenia*."

"2. Bulbils formed apparently by transmuted spore-producing energy and occupying the place of sori, *i. e.* on the under side of the pinnæ—a position so far, I believe, quite unrecorded in connection with any of the Filices."

"3. A new form of proliferation altogether, viz., proliferous prothalli arising from pseudobulbils produced by a different transmutation of the reproductive force, and evolving plants only after the prothalli have produced the usual sexual organs common to prothalli resulting from spores."

The reading of this paper aroused some little interest, but was received decidedly *cum grano salis*, especially as it was then not in my power to do more than lay my report before the Linnean Society, the resulting plants being too small to display their parentage, while the pseudobulbils and preliminary phenomena had of course successively passed away. I promised, however, that in the following autumn I would lay plants before them, and also, if possible, the curious pseudobulbils themselves. Accordingly, on Nov. 20, I did so, so far as plants were concerned; but unfortunately, as I then thought, though it turned out to be immaterial, I could only exhibit pinnae of *Clarissima* bearing very immature excrescences, owing to the plant having been more in the open air than in 1883, and the year having been a very dry one, the result being that the indusia were not even lifted, and nothing approaching the pear-shaped bodies was visible. When the indusia were raised, however, an experienced eye could detect that the bodies they covered were of a very abnormal character; and though altogether unlike the pear-shaped bodies of the previous year (*Plate VI., Fig.* 1) were equally unlike what normal sporangia would appear at the same stage. I give an enlarged representation of one of the pseudosori (*Plate VI., Fig.* 2), by which it will be seen that they consisted of a considerable number of clavate bodies occupying the place of sporangia. I expressed my opinion that under more favourable circumstances some four or five of these bodies would have assumed predominance and become pear-shaped, the rest aborting, as in many analogous cases—an opinion which was strengthened by the fact that among the bases of the pear-shaped bodies of 1883 there were numerous thready and shrivelled bodies, which were exactly such as would result from such a process.

The outcome of this exhibition was that Dr. Murie, Professor Thiselton Dyer, and another, requested me to supply them with material for further investigation. I did so, and Professor Dyer deputed Prof. F. O. Bower to examine the matter, with the result that my observations were confirmed throughout ; Prof. Bower, on December 18, giving his report, and stating that an undoubtedly new phenomenon was thereby shewn to exist, viz., the reproduction of a fern by sexual action taking place upon prothalli which had been generated without the mediation of the spore, to which phenomenon he gave the term Apospory. Prof. Bower upon that occasion demonstrated that the prothalli sprang from the stalk of the sporangia, that portion of the sporangium which would normally produce the capsule filled with spores being either entirely aborted at an early period or partially formed and then thrown off. In some cases they appeared to have exhausted their energy in endeavouring to produce spores, since in every case where they had made a distinct advance in that direction they were afterwards aborted altogether.

This singular fact throws, I think, some light upon the formation of the pear-shaped bodies of 1883, where we may assume that the extra stimulus of a specially favourable season may have impelled most of the would-be sporangia too far in the normal direction, the result being their abortion and the monopoly of the whole of the vigour of the pseudo-sorus by a select clique of four or five of what we may consider the more conservative part of the community.

The growths of 1884 seemed most unlikely subjects for the production of prothalli and plants, but they have proved themselves, so far as prothalli are concerned, to be capable of producing them in far greater numbers than those of 1883, the large majority of the clavate bodies having, even with quite cool treatment, produced prothalli, which I have no doubt whatever will yield plants in due time.* I have brought down with me a few pinnae of *Clarissima* shewing the prothalli, and it will be observed that it is almost immaterial whether the pinnae be laid down with the excrescences uppermost or undermost, as under close culture they develop in either case, actually lifting the pinnae from the soil when developed underneath them.

It will thus be seen that the fact has been established beyond all doubt that Colonel Jones's beautiful *Athyrium* forms a new link between the ferns and the flowers, a fact of which he probably little dreamed when rescuing it as he did, literally "a brand from the burning." My thanks, and very sincere ones, are due to him, and also to Mr. Wollaston for providing me with materials and aiding me in carrying my investigations through, and getting their truth accepted and confirmed by the best authorities.

In my opening remarks I alluded to a second discovery of Apospory, for which we are indebted to Mr. G. B. Wollaston, a discovery which quite throws into the shade that in *A. F.-f. Clarissima*, the prothalli in this case (*Polystichum angulare*, var. *pulcherrimum*, Padley) being actually produced altogether independently of the sori, without even a local connection, springing, as they do, from the extreme tips of the pinnae. So far, although antheridia and archegonia have been observed on these prothalli, and their true nature is thus beyond a question, the process of reproduction has not been completed; plants have not resulted. The case, however, constitutes not merely a second one of Apospory, but also a new form of the phenomenon.

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* June, 1885. They did so in profusion.—*C. T. D.*

To Prof. Bower I am indebted for illustrations of the life cycles, normal and abnormal, of the Filices, including the two forms of Apospory (*vide Plate VI.*), of which illustrations I give an enlarged view upon the diagram before you. The normal cycle (*Fig.* 3) consists, as already stated, firstly, of the spore-bearing fern or sporophore, then the sporangium, spore, prothallus, the sexual organs thereon, and finally the reproduction of the sporophore. This normal cycle is, however, both lengthened and shortened by abnormal methods of reproduction; thus it may be lengthened by the parent fern producing young plants by adventitious budding on the upper surface of the frond, a faculty which the prothallus occasionally also possesses, viz., of producing other prothalli by vegetative reproduction, the one spore thus yielding numerous plants of the sporophore generation (*vide Fig.* 4, *for both phenomena*). On the other hand, the cycle may be shortened by the prothallus yielding plants of the sporophore generation by direct budding without sexual action, *i.e.*, Apogamy (*Fig.* 5), or by Apospory, where, in the case of *A. F.-f. Clarissima*, the spore is missing from the cycle; the stalk of the sporangium producing the prothallus (*Fig.* 6); while in the other case of the Polystichum, not merely the spore but the sporangium also is excised, the prothallus springing directly from the frond of the sporophore (*Fig.* 7). The further illustration (*Fig.* 8) relates to one of the fern allies (Isoetes lacustris), but is exactly paralleled in the fern family by the buds I have already described as formed in the place of sori, *i.e.*, on the *under* surface of the frond in the plumose Athyria.

In conclusion, while thanking you for the patient hearing which you have accorded to what I fear has been to some of you a rather dry subject, I would ask those gentlemen present who take a special and active interest in our beautiful native ferns to examine their plants anew, and with special care, with the object of discovering, if possible, other cases of Apospory, or perhaps new phenomena of a kindred nature. Bearing in mind the wonderful capacity for variation in the most unexpected directions which our British ferns possess, whether under cultivation or in their natural state, and the singular fact that Nature, left to herself, supplies the most marked departures from the normal forms, *A. F.-f. Victoriae* and *Acrocladon*, for instance, among the hardy ferns; bearing, I say, these facts in mind, it is singular that so far little attention has been paid to them by professedly scientific men, the fact of their variability seeming rather to earn for them the contempt of botanists, who do not scruple to call them mere monstrosities.

Now, my belief has long been that this faculty of variation affords a rich field of research for morphologists, amateur or scientific, a belief which I need hardly say has been quite confirmed by the discoveries which I have had the honour of laying before you this evening. To render research, however, profitable, it is essential that when unusual phenomena are remarked they should be at once investigated as thoroughly as possible, and, their true nature being established, that some permanent record be made of the fact. Each new fact becomes thereby a stepping-stone for further research, and general science is so much the richer; while without this, the discovery is apt to die with the discoverer, or, at the best, become mere hearsay, confined to the knowledge of a few, and rarely forming a reliable basis for additional data.

Rainfall at Clifton in 1884.

By GEORGE F. BURDER, F. R. Met. Soc.

TABLE OF RAINFALL.

	1884.	Average of 30 Years.	Departure from Average.	Greatest fall in 24 Hours.		Number of days on which ·01 in. or more fell.
				Depth.	Date.	
	Inches.	Inches.	Inches.	Inches.		
January ...	4·820	3·251	+1·569	0·738	26th	20
February ...	1·849	2·318	−0·469	0·291	23rd	18
March	2·689	2·216	+0·473	0·985	3rd	15
April	1·117	2·144	−1·027	0·340	4th	11
May	2·501	2·362	+0·139	0·733	2nd	12
June	3·867	2·623	+1·244	2·440	28th	9
July	3·665	2·959	+0·706	0·922	23rd	19
August ...	2·744	3·595	−0·851	0·692	30th	12
September ...	1·998	3·355	−1·357	0·328	1st	19
October ...	1·167	3·793	−2·626	0·342	8th	7
November ...	1·686	2·856	−1·170	0·407	2nd	13
December ...	5·289	2·841	+2·448	1·165	5th	18
Year	33·392	34·313	−0·921	2·440	June 28th	173

Remarks.—The total rainfall of the year differs but little from the average of 30 years, showing a deficiency of something less than one inch. Six months were in excess of the average, and six were in defect. The rainy months were mostly in the first half of the year, and the dry months mostly in the latter half, with the result that the entire fall of the first half of the year exceeded the entire fall of the second half—a noteworthy deviation from the ordinary rule. From August to November the deficiency was continuous and very marked. The fall in October was the smallest recorded here in that month during a period of 32 years, and the aggregate fall of the four months was also the smallest recorded here in the same four months. Nevertheless, no general inconvenience was experienced in these parts, the normal rainfall of those months being sufficient to allow of a large reduction without any approach to absolute drought. In some of the northern towns the scarcity of water was at one time becoming serious.

The rain in December largely exceeded the average, amounting to 5·289 inches, and the whole of this quantity fell in the first 19 days of the month, the last 12 days being rainless. December was the wettest month of the year, and April was the driest.

A remarkably heavy downpour occurred in the night of the 28th of June, when 2·44 inches fell within ten and a half hours. On the fifth of December also the fall exceeded an inch.

The year was almost free from snow, no greater depth than half an inch having been registered.

Meteorological Observations, as regards Temperature, taken at Clifton, 1884.

By H. B. JUPP, M.A., F. R. Met. Soc.

THE observations from which the following tables are derived have been taken at 8.30 a.m. daily. The Thermometers used, with the exception of that for the Ground Temperature, are kept in a Stevenson cage; and in all the readings the requirements of the Royal Meteorological Society are strictly complied with.

1884 TEMPERATURES.

MONTH.	Maximum in Shade.		Minimum in Shade.		Mean in Shade.	Minimum on Ground, Lowest recorded.
	Highest recorded.	Mean.	Lowest recorded.	Mean.		
January ...	54·4	48·0	29·1	40·3	44·17	29·1
February ...	53·6	46·5	28·8	38·1	42·30	27·8
March ...	68·1	51·2	30·9	38·6	44·90	28·1
April	57·7	52·1	30·8	37·9	45·01	25·1
May	80·1	62·9	38·9	43·8	53·35	36·2
June	80·1	69·0	42·0	50·7	59·85	37·7
July	75·5	69·2	48·0	52·3	60·73	45·7
August ...	87·5	73·3	47·5	55·7	64·50	44·8
September ..	76·3	65·9	42·1	53·0	59·44	38·6
October ...	62·8	55·2	30·8	42·6	48·90	30·3
November ..	57·8	46·6	22·6	36·6	41·60	23·7
December ...	54·9	47·0	32·0	39·3	43·15	27·2
Year 1884...	87·5	57·44	22·6	44·07	50·66	23·7

Year 1883...	82·5	54·54	20·9	42·88	48·71	19·3
Year 1882...	78·5	55·46	21·9	43·62	49·54	20·6
Year 1881...	86·9	55·44	12·3	42·92	49·18	5·8

MONTH.	Number of Days on which the Minimum Ground Temperature was below 32°.	Number of Days on which the Minimum Air Temperature was below 32°.	Number of Days on which the Maximum Air Temperature was below 32°.	Number of Days on which the Mean Air Temperature was below 32°.	Humidity in percentage of Saturation. Mean of Values at 8.30 a.m.
January ...	4	3	0	0	90
February ...	4	2	0	0	84
March ...	10	2	0	0	82
April	11	2	0	0	79
May	0	0	0	0	78
June	0	0	0	0	72
July	0	0	0	0	75
August ...	0	0	0	0	75
September...	0	0	0	0	87
October ...	4	2	0	0	85
November ..	12	8	0	1	90
December...	6	0	0	0	89
Year 1884...	51	19	0	1	82·2
Year 1883...	79	40	0	6	82·8
Year 1882...	63	26	2	7	—
Year 1881...	94	60	11	24	—

The year 1884 was warmer on the average than any one of the three years that preceded it. The only month in which the mean shade temperature fell below the average was April. The number of frosty nights and days was also far below the average of these three years.

The Heart-beat.

ABSTRACT OF PAPER

BY G. MUNRO SMITH, L.R.C.P.LOND., M.R.C.S.

WHEN the hand is firmly pressed against the left side of the chest, we can readily feel the rhythmical thumping sensation due to the movements of the heart beneath the ribs. These movements, which in thin people can be seen as well as felt, occur, in health, with perfect regularity, and are the outward sign of that enormous though unobtrusive work on which our very existence depends.

The heart is a strong, hollow, muscular cone, divided into four cavities, which communicate with each other and with the whole circulatory apparatus of the body. Every time it "beats," or contracts, it squeezes the blood into the arteries with sufficient energy to make it travel at the rate of one foot per second. As the tubes into which it flows become ultimately extremely minute, there is great resistance to the onward stream, and a corresponding force is necessary in the central pump. For instance, each contraction squeezes out from nine to twelve ounces of blood, and does enough work to lift a weight of three pounds to a height of three feet. As this occurs sixty times a minute at least, we can calculate that in 24 hours this small engine does work equivalent to raising 124 tons to a height of 124 feet. The heart of old Sir Moses Montefiori, whose hundredth birthday was celebrated a few months ago, must have beaten more than 5000 millions of times, and manifested enough energy to raise five millions of tons to a height of eight or nine hundreds of miles. Yet all this is done so smoothly and harmoniously that we are not generally conscious even of the existence of such an organ. By applying to the chest wall an instrument called a cardiograph we can magnify these movements, and by suitable apparatus obtain a record of each contraction written by the heart itself. By listening with a " stethoscope " we can hear the sounds made by the blood being driven through its chambers or stopped by its membranous valves, for, like other pumps, it is so constructed that fluid can travel through it in one direction only. In some simple organisms there are no valves. The heart in these is a mere muscular tube connected at either end with blood vessels, and the fluid travels first in one direction for a certain number of beats, and is then reversed and forced in the other. This can be easily seen ; and in cold-blooded animals, such as frogs and turtles, the heart will continue to beat for hours or even days after its removal from the body, provided it be kept moist.

By these and other methods of investigation a vast amount of knowledge has been gained as to the mechanism of the cardiac movements, and much light has been thrown on that most interesting question : " *Why* does the heart beat ? " Like most problems in physiology, when pushed far enough, this baffles our endeavours. Dr. Brown-Sequard says that it is the presence of impure blood that stimulates its muscular fibres to contraction. Others say that it is the mere contact of fluid. Yet the heart will beat when empty, so this hypothesis does not hold.

Then there is the commonly-received theory that the nerves scattered throughout the heart-substance, and those connecting it with the brain, are the cause of its movements. Undoubtedly they are to some extent, but not altogether, for the developing heart beats before it contains either nerve or muscle. Dr. Carpenter says :—" The essential cause of the rhythmical contraction of the heart must still remain an unsolved question."

The explanation I am going to suggest will seem to some no explanation at all. It is this: that the heart beats because it inherits the power of beating; that as an animal transmits to its offspring its form and instincts, so it hands down this power of rhythmical contraction of the heart. It is a question of inheritance. We inherit a limited life, and a heart whose power is also limited. Nay, more; the heart of an animal always begins to beat at the same time as its parent's did before it. If you put a hen's egg into a warm, uniform temperature for a couple of days and then carefully chip off the shell, you will see, lying upon the yolk, a small, red, palpitating spot, which is the future heart. I say *future,* because as yet the heart is merely a mass of cells, hollowed out in the centre, and has neither muscle nor nerve in its walls. Yet it beats regularly and always begins at about the same time—towards the end of the second day of incubation—because its father's did before it. This great principle of inheritance, the most important law in the organic world, is no mean explanation of the heart-beat, although at first it seems ridiculously simple. How that movement originated ages ago we are not concerned with now.

The reason of the *regular rhythm* of the heart-beat is also unknown; but we notice, as Dr. Michael Foster has observed, that rhythm is the order of the Universe. The moon and the earth and other planets have stated intervals in which to revolve; our brains have alternately periods of rest and activity; the lives of men and all other animals have fixed durations, beyond which they cannot go. They gather strength, beat, and cease, as the heart gathers strength, contracts, and lies quiet until the next pulsation. "The heart," says Foster, "is the reflex, in little, of the cycles of the Universe."

Reports of Meetings.

GENERAL.

DURING the past Session there have been nine meetings of the Society—eight ordinary and one special—all held in University College.

The first was on Thursday, October 9th, when Mr. Thomas Morgans, C.E., gave an account of the manufacture of paper from wood. Poplar, spruce, or some other wood, comparatively free from resinous material, is chopped up by powerful machinery, and then boiled at high pressure for four or five hours with a solution of caustic soda, or with sulphite of lime or magnesia. The result is a pulp similar to that used in ordinary paper works; and the subsequent processes of manufacture are those usually followed. Good specimens of the paper were exhibited, and also a small casting in wood-pulp board. Dr. Burder then made an interesting communication on the "Recent Eclipse of the Moon," which will be found on page 166.

On November 6th, Mr. G. Munro Smith read a paper on the "Heart-beat," an abstract of which is printed at page 234. Prof. Ramsay, Ph.D., subsequently gave a vivid description of "The Volcanic Phenomena in the United States National Park on the Yellowstone River," as observed by him during a recent visit.

On December 4th, Mr. W. A. Shenstone, F.C.S., gave an account of "The Physiological and Chemical Work of Jean Baptiste Andrè Dumas," illustrated by a large number of his original experiments, and by models of his appliances.

On January 8th, 1885, Mr. William Hancock, F.L.S., F.R G.S., read a paper on "The Volcanoes of Central America, with an account of the recent active phenomena observed in that region." He alluded to the old and incorrect definition of a volcano as "a burning mountain shooting forth smoke and flame." A volcano was a hole in the outer crust of the earth, by means of which a communication existed between the heated interior and the surface; and through which, from time to time, steam, gases, scoriæ, and molten rock, or lava, were ejected. It must not be imagined, however, that the rocks of the interior of the earth were necessarily in a molten condition. Physicists rather inclined to the opinion that the interior of the earth was solid, though kept so only by the enormous superincumbent pressure, on the diminution of which the rock assumed the molten form. The fact has been established that water is an important, if not indispensable, agent in volcanic eruption. Relief of pressure causes the water, held in a liquid condition within the rocks, to flash into steam, and give rise to paroxysmal, or continuous, eruptions. Variations in barometric pressure may in some cases determine a volcanic eruption. At Stromboli a variation of 2 inches of mercurial pressure has been noted in a short space of time; and that would mean an increase or decrease of two million tons pressure per square mile. After describing the steam geysers in Formosa, in the tubes of which he had seen molten sulphur, the condition of which made possible an estimate of the temperature, Mr. Hancock gave a full and interesting account of the volcanic phenomena he had observed in many parts of Central America. One of the most striking facts was that relating to a line of three volcanoes named Pacaya, Agua, and Fuego, of which that in the median position had never, within historic times been known to be in eruption, though the other two had frequently been active. The volcano of Izalco resembled Stromboli in being continuous in its action;

though periods of quiescence, followed by eruptions approaching the paroxysmal type, had been known to last for two years. It had existed since 1798, and had now reached the height of 2500 feet. An eruption occurred on an average every 13 minutes. A specially interesting account, also, was given of the earthquake phenomena in San Salvador, and the formation of a new volcanic cone in a neighbouring lake.

At the meeting on February 5th, Mr. Edward Wethered, F.G.S., F.C.S., described some original researches on the structure and formation of coal. He advocated, with Prof. Huxley, the microscopical examination of sections cut from the coal at various depths, as the best method of investigating the nature of its formation; and gave as his opinion that the plants from which coal was formed were more closely allied to the *aquatic*, than to the *terrestrial*, Lycopods.* Prof. S. P. Thompson, D.Sc., then exhibited and described some scientific appliances for the rapid extinction of fire. One was the "Automatic Sprinkler," an arrangement by which, if the temperature of a room rises much above a summer heat, a large number of jets of water are liberated by the melting of a fusible alloy. In America, where factories are commonly fitted with this appliance, a great many fires have thus been automatically extinguished by the action of their own temperature. Another appliance described by Prof. Thompson was the "Harden Hand Grenade," which, when thrown into the fire, bursts, and liberates large quantities of steam or other vapours, which prevent further combustion.

A special general meeting was called on February 21st, to receive a communication from Mr. Charles Druery, F.L.S., of London, on "The Aposporous Production of Prothalli of Ferns." To this meeting members of the Bristol Microscopical Society, and others interested in the subject, were invited. This paper will be found on page 211.

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* This paper is printed in full in the *Journal of the Royal Microscopical Society*, Series 2, Vol. 5, Part 3.

On March 5th, Mr. J. G. Grenfell, F.G.S., gave an account of a stay of six weeks which he had made at Port Royal, Jamaica. He described the situation of the place, and gave an account of the different kinds of fish which are met with in the harbour, and the methods of catching them. These included the devil-fish, sharks, king-fish, bonitos, jack (cavaux), the remora, flying gurnards, diodon, tetraodon, cestracion, and others. He also gave an account of the many kinds of crabs found on the shore, and of the butterflies found on the island. Numerous specimens were exhibited.

On Tuesday, March 31st, Prof. Ramsay, Ph.D., gave a lucid description, illustrated by numerous experiments, of the researches by Prof. Lodge and Mr. Aitken (of the Royal Society of Edinburgh), which showed conclusively the part played by dust particles in serving as nuclei on which fog may form, and that the absence of dust from the air renders the formation of fog impossible. Much interest was excited, and an animated discussion followed; after which Mr. S. H. Swayne read an account, by Mr. Edward Wilson, of the whale recently stranded in the Severn. This account will be found at page 204.

The 23rd annual meeting of the Society took place on May 7th. After the transaction of the usual business, Prof. Lloyd Morgan, F.G.S., read a paper of especial local interest, entitled "Sub-aerial Denudation and the Avon Gorge." This is printed at page 171. Mr. Alfred E. Hudd then mentioned the recent occurrence in the neighbourhood of Bristol of a rather rare bird, the "Pied Fly-catcher" *(Muscicapa atricapilla)*. "In Mr. Edwin Wheeler's list of the birds observed in the Bristol district which was published in our Proceedings for 1875 (New Series, Vol. I., page 366), this species is described as 'a rare summer visitor'; the only one recorded from the district at that time having been observed near Long Ashton many years before. In 'Winscombe Sketches' (page 114) Mr. Theodore Compton writes:—'The Pied Fly-catcher is a very rare visitor in this county. It has been shot near Taunton; and about 12 years ago (*i.e.*, 1870) a pair built in a wall plum-tree in Mr. Clothier's garden, near Street. Being a true bird-lover, he gave strict orders that the birds should be protected, and he had the pleasure of seeing them bring out their brood.' The species does not appear to have been hitherto recorded from Gloucestershire. Our recent visitor was first observed on April 25th, while flying over a stream near Henbury, by Mr. Alfred C. Pass and Prof. Lloyd Morgan. The next day, a little further up the stream, Mr. Pass and Mr. Hudd watched for some time the pretty movements of the same bird—a male—while engaged in chasing his prey. From the branch of a willow, overhanging the stream, he darted on the flies as they passed beneath, returning after each capture to his post of observation. The females are said to arrive in this country some days after the males, so it was arranged to pay frequent visits to the spot for the next few days; and on the 27th Prof. Lloyd Morgan was fortunate in finding that the first visitor had been joined by his mate; the female being rather less brightly coloured than the male. It was now hoped they would build, and rear their young in the neighbourhood; but, though repeated visits were made to the locality, no more was seen of them. They had probably, after meeting *by appointment* at the trysting-place, where they were fortunately observed, continued their flight to the hills of Yorkshire or Westmoreland, where they are much more frequently met with than in the South and West of England. They are sometimes found near the coast, where they alight to rest before resuming the journey northward, but seldom stop to nestle there."

ARTHUR B. PROWSE, *Hon. Reporting Sec.*

BOTANICAL SECTION.

THE members of the Section have continued the customary excursions on Saturday afternoons during the summer, in accordance with a published programme.

On Thursday evening, April 30th, 1885, the annual meeting of the Section was held in University College, and the president, Prof. Leipner, communicated some notes on fresh-water algæ.

Five new species of flowering plants have been added to the local Flora during the past year; and the Secretary has collected much information for the work now in course of publication.

Part V. of the "Flora of the Bristol Coal-field" does not contain the whole of the Monocotyledones, the Glumiferæ having been reserved for another year.

J. W. WHITE, *Hon. Sec.*

CHEMICAL AND PHYSICAL SECTION.

THE Section has met regularly during the winter months, and papers have been read by Prof. Ramsay and Mr. Cundall, Prof. Thompson, Prof. Shaw, and by Messrs. Berry and Shenstone.

On May 9th, the London Physical Society visited Bristol, at the invitation of the Presidents of our Society and of the Section. The arrangements for this visit were carried out by a committee appointed by the Section, in accordance with a resolution passed by the Society at one of their meetings in 1884.

W. A. SHENSTONE, *Hon. Sec.*

ENTOMOLOGICAL SECTION.

DURING the year only one out-door excursion was taken by the Section. Wotton-under-Edge was visited in June, and a large number of species were taken.

At the in-door meetings of the Section no papers of importance have been read, but a very large number of specimens of different orders, both British and foreign, have been exhibited, including many rare and interesting species.

GEORGE HARDING, *Hon. Sec.*

GEOLOGICAL SECTION.

ON May 10th, 1884, an excursion was made to Banwell, when the bone cave and also the deep cave were examined. In the latter is a remarkable deposit or incrustation of sulphate of baryta, which appears, hitherto, to have been unnoticed; probably having been mistaken for stalagmitic carbonate of lime.

At Whitsuntide an excursion, extending over four days, was taken to the neighbourhood of Bournemouth and Christchurch. The coast was examined, and the Barton clay beds yielded a large number of fossils. This excursion, from Saturday to Tuesday, proved very satisfactory to all who joined it.

On September 10th, by invitation of Mr. Charles Richardson, C.E., an excursion was made to New Passage, to examine the tunnel cutting on the South Wales Union Railway. The ancient river-bed of the Severn, consisting of a great deposit of gravel, and also the overlying deposit of alluvium and peat containing trees, were carefully pointed out by Mr. Richardson and Mr. Jones.

On November 26th a meeting was held at University College, to hear a paper by the president—Prof. Lloyd Morgan—on the carboniferous limestone at Long Ashton.

A. C. PASS, *Hon. Sec.*

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